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ANNUAL REPORT OF THE NATIONAL RESEARCH PROGRAMS 1978

NATIONAL PROGRAM STAFF
SCIENCE AND EDUCATION ADMINISTRATION
U.S. DEPARTMENT OF AGRICULTURE

This publication reports research involving agricultural chemicals. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, beneficial insects, desirable plants, and fish or other wildlife--if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

Issued September 1979

FOREWORD

Crop Protection

Research included in this report is conducted to improve crop protection technology including biological and chemical methods to control insects, diseases, weeds, nematodes, and other pests while at the same time retaining or improving the quality of our environment.

New multidisciplinary concepts for pest management and control include the development and integrated use of conventional pesticides; behavior control chemicals such as pheromones and attractants; genetic techniques, parasites, predators, pathogens, and weed-feeding insects; disease and insect resistance in host plants and plant growth chemicals.

The research workers in the Science and Education Administration (SEA) publish the results of their investigations in the open literature as quickly as sound scientific judgment warrants. This is an administrative report to provide for those interested in the results of this work a brief overview of the scope of the activities and examples of recent findings, some of which still have not been released by publication. No attempt is made at completeness.

This report outlines the research for which the Crop Protection Staff is responsible and provides a brief description of recent accomplishments at the various locations throughout the United States. The report is organized by SEA National Research Programs, each of which describes a separate subject matter area. The SEA National Research Programs are subdivided into Technological Objectives which more specifically describe the objectives of each area of research.

Readers who have comments or inquiries are invited to contact either the National Program Staff or, more appropriately, scientists at the locations where the research is conducted.

M. D. Levin

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Chief
Crop Protection Staff

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SUMMARY

Crop protection research is an integral part of the total research program in the Science and Education Administration. The research is described under eight National Research Programs (NRP) and two Special Research Programs (SRP). A brief summary of each NRP and SRP is provided in the front of this volume. More detailed reports for each NRP and SRP follow with selected examples of progress and publications.

NRP 20220 Insect Control - Horticultural Crops

The objective of this National Research Program is to provide through research new or improved methods which may be used to reduce the losses to horticultural crops caused by insects and mites. This research is conducted at 18 locations by 54 scientists and is currently being reported in over 100 scientific publications. Significant advances have been made in pheromone and attractant research on California red scale, yellow scale, peachtree borer, bean cutworm, greenhouse whitefly, corn earworm, European corn borer, citrus mealybug, and codling moth. Improvements in quality and reductions in cost have been made in rearing of fruit flies, cucumber beetles, and parasites of Diabrotica beetles and citrus mealybugs. Additional predators or parasites look promising for pickleworm, citrus mealybug, and pecan insects. Superior chemical controls have been developed for Japanese beetle larvae, pecan weevils, and pecan aphids.

NRP 20230 Cotton and Tobacco Insects

Research is conducted to develop new and improved practices for controlling insects and mites attacking cotton and tobacco. Practices may be used alone or in integrated systems on a farm-by-farm or area-wide basis, but emphasis is placed on integration of several methods into a total production system since this approach provides the greatest potential for improving insect control. Control technologies being developed include genetical methods, attractants, parasites and predators, microbial agents, insect and plant growth regulators, insecticides, cultural practices, and resistant varieties. Research is also conducted on survey methods, loss thresholds, and descriptive and predictive insect population models to develop a basis for implementing various control technologies and integrating them into production systems.

Recent advances in control technologies include: (1) an improved sterility method for the boll weevil, (2) development of an artificial diet for a larval parasite, (3) mass production and aerial release for an egg parasite, (4) the development and commercialization of an adjuvant to improve efficacy of microbial agents, (5) conditional registration of an insect growth regulator for the boll weevil, (6) identification of promising insecticides for control of the bollworm complex, and (7) development of a highly selective aphicide for use on tobacco. Also, improvements were made in quantifying populations of boll weevils, bollworms, and budworms based on trap catches and in predicting populations of the bollworm complex with computer-based models.

NRP 20240 Insect Control - Grains, Forages, Sugar Crops, and Oilseeds

The primary objective is to develop new and improved control methods, tactics, and strategies to reduce insect related losses of corn, small grains, sorghum, grass and legume forages, sugarbeets, sugarcane, soybeans, peanuts, sunflowers, and other field crops. This research, in cooperation with State and industry scientists, develops control strategies and integrated pest management (IPM) systems to protect more than 300 million acres of field crops and one billion acres of grazing land from insect attack. During the past year, significant progress was made in developing varieties of crops resistant to insect attack, the use of insect pathogens and entomophagous insects to control pest insects, the development of kairomones, pheromones, and insect growth regulators to manage insect populations, the development of economic injury levels, and insecticide application protocols, insect rearing methods, and the development of "genetic control" methods such as release of unadapted biotypes into hostile environments. Pilot tests involving the implementation and integration of various control tactics to control insect pests of wheat and sugarbeets were conducted.

NRP 20250 Basic/Noncommodity Research for Insect Control

This National Research Program includes basic research on entomological problems regardless of the affected commodity or U.S. Department of Agriculture mission. Entomologists, chemists, physiologists, ecologists, and behaviorists work together in teams to provide the in-depth fundamental knowledge needed in applied research programs in insect management. Significant progress has been made in the development of new and improved principles and practices of arthropod control based on the selective disruption of growth, development, and reproduction. Insect control practices based on behavior and ecology have been improved along with improvements in the methodology of insecticide use.

NRP 20260 Biological Agents for Pest Control

Research on biological control of agricultural pests and insect taxonomy is carried on at more than a dozen locations by approximately 70 scientists and is reported in more than 135 scientific publications. Several potentially important parasites of injurious insects and weeds have been successfully established and progress has been made on the production and registration of several viruses. In fact, one has been taken over by a commercial firm and is on the brink of full registration. Some progress has been made on insect diets for insect parasites and predators that do not contain insect host material, pointing the way for eventually dispensing with the need for hosts when rearing their parasites and predators. New insecticides have been identified which cause minimal mortality to biological control organisms, thus promising improvements in the feasibility of integrating biological control into integrated systems of pest management. Significant progress in the taxonomy of several groups of moths has been made and several other taxonomic works of importance have been completed.

NRP 20270 Crop Disease Control and Noncommodity Research on Plant Pathogens and Nematodes

Research efforts of scientists in this National Research Program continue to aid in extending our knowledge concerning basic aspects of plant pathogens and nematodes. Increasing intensity of nematode problems on corn and soybeans adds to the importance of this research area. The development of races of soybean cyst nematode is of particular concern. We are cautiously optimistic that the possibility now exists for development of practical biological control of some important soilborne disease organisms. Progress has also been achieved in the area of transfer of genetic information from bacteria to plants. Some genetic products may be replaceable, thus allowing the introduction of desirable genetic traits such as increased photosynthetic efficiency and nitrogen fixation by nonlegumes. Additional concerns about factors such as energy and water make plant protection and the reduction of crop losses increasingly important. We have placed additional resources in research areas directly or indirectly associated with integrated pest management which recognizes the necessity for a team approach to improve crop protection capabilities. Multicropping systems have been developed and tested which give improved profit margins to the producer and increased yields of products for the consumer. Research efforts will be continued and expanded to aid in implementing the most effective combinations of improved resistant varieties, biological control, improved cultural practices, and judicious use of chemicals for more effective systems of crop production.

NRP 20280 Weed Control Technology for Protecting Crops, Grazing Lands, Aquatic Sites, and Noncropland

Excellent progress was made in developing a basic understanding of the life cycle of weeds, including germination of seeds, growth, reproduction, and competitiveness with crops in relation to development of control technology. Research results are also indicating how allelopathic effects and the effects of naturally occurring secondary chemicals in weeds and crops can be used in developing weed control technology. More than 70 new chemicals were evaluated for their weed control effectiveness and safety in about 60 crops, aquatic sites, and rangelands. Basic research in understanding the penetration, absorption, translocation, sites and mechanisms of selective action, and metabolic fate in plants, soil, water, and the environment has increased the performance efficiency and activity of herbicides. The first plant pathogens in agricultural history are being developed for weed control and some are now ready for widescale use in rice, soybeans, and other crops. More than 20 species of insects are being developed for weed control in crops, rangelands, and aquatic sites. Unique herbicide application equipment such as the rope wick applicator, recirculating sprayer and endless belt applicator that applies herbicides to weeds in crops without getting the herbicides on crops is being developed and some is in widescale use. A technique for

applying herbicides directly on crop seeds in the row and obtaining excellent weed control without crop injury was discovered in 1976 and was extended and improved in 1978. Outstanding progress was made in developing new weed control technology that will increase the effectiveness and safety of integrated weed management and pest management systems.

NRP 20290 Agricultural Chemicals Technology for Crop Protection and Modification

More than 150 new chemicals were evaluated for their effectiveness and safety as herbicides, insecticides, fungicides, nematicides, insecticides, and plant growth modifiers. New witchweed seed germination stimulants and inhibitors were synthesized and evaluated that offer promise of improving control technology. Outstanding progress was made in improving techniques and systems for the discovery, evaluation, and development of new, improved, selective, biodegradable, and safe pesticides and plant growth modifiers. Progress was also made in developing a basic understanding of their penetration, absorption, translocation, sites of action, mechanisms of action, and their metabolic fate and effects in plants, soil, water, and other components of the environment. Improved application equipment and controlled release formulations of agricultural chemicals were developed that will increase their performance effectiveness and safety, reduce the need for excessive use, and reduce the risks to nontarget organisms and other components in the environment. Basic research on how herbicides kill plants resulted in the development of new chemicals which reduce high temperature damage to crops, reduce cold hardiness of plants, eliminate rancidity in oils, change fatty acid composition of oil seed, and change insect lipids, making them more susceptible to control. This discovery will also provide plant breeders with a screening technique that will aid in the development of crops with greater heat or cold hardiness. Basic research on surfactants and other additives in agricultural chemical formulations is providing fundamental information that can be used to optimize residual activity, penetration, absorption, and translocation, stability in formulations, and aid in better understanding the metabolism and fate of agricultural chemicals.

SRP Minor Use Pesticides

Scientists in Agricultural Research cooperated with State scientists on 71 food requests in IR-4 during 1978 and 405 ornamental requests. These projects were conducted at 17 locations in AR. Of these projects 52 food projects and 301 ornamental projects were completed in 1978.

SRP Pilot Testing of Alternative Methods for Pest Control

Twenty-nine pilot tests are underway involving ecologically selective methods of managing insects, weeds, plant pathogens, and nematodes. The Deputy Director's Pilot Test Fund provides resources to advance certain desirable technologies toward commercial use which otherwise would remain undeveloped.

National Research Program 20220

INSECT CONTROL - HORTICULTURAL CROPS

Technological Objective: New and improved methods to reduce losses caused by insects and mites to fruits, vegetables, nut trees, and nursery stock.

This National Research Program is composed of seven subelements which have as their collective objective to provide through research new or improved methods which may be used to reduce the losses to horticultural crops caused by insects and mites. The program subelements are identified as the control of insect pests of citrus, tropical and subtropical fruit, pome fruit, stone and small fruit, tree nuts, vegetables, and shade trees, nursery, ornamental, and other horticultural crops. Providing technology for protecting horticultural crops from insects and mites is an essential component for the production of steady, reliable, and safe supplies of these crops that are reasonable in cost to the consumer, yet profitable to the farmer.

NPS Contact: M. L. Cleveland

Research Locations:

5202 Fresno, California
5210 Riverside, California
7616 Miami, Florida
7606 Orlando, Florida
7706 Byron, Georgia
5221 Hilo, Hawaii
5220 Honolulu, Hawaii
5704 Kimberly, Idaho
3303 Vincennes, Indiana
3302 West Lafayette, Indiana
1108 Beltsville, Maryland
3307 Wooster, Ohio
7711 Charleston, South Carolina
7308 Brownwood, Texas
7202 Weslaco, Texas
5805 Yakima, Washington

Following are some examples of recent progress:

California growers now have better tools for use against red scale and yellow scale - Riverside, California. California red scale continues to be one of the key pests in citri-culture but viable methods have already been worked out for its detection, and for the survey and monitoring of field populations with live pheromone producing virgin females. The synthesis of the

pheromone's components will reinforce and augment previous findings. These findings will enable the citri-culturist to regulate scale populations much easier under the concept of a true insect pest management scheme. In areas where no scale is established by early detection, scale can be prevented from becoming established. By monitoring populations a true picture of scale densities can be determined. By using the pheromone in conjunction with natural enemies, the scale may possibly be controlled without the use of conventional insecticides. Overall, there should be diminished use of insecticides because of more precision in defining damaging populations and better timing of insecticide applications. The synthesis of the yellow scale pheromone also adds to proper insect pest management against this scale which is found in the same habitat as the red scale.

Progress made in host plant resistance research - Riverside, California. Onion thrips resistance in 'Nebuka' is still identifiable 40 years after first report. Susceptibility to muskmelon necrotic spot virus found in L.J. 90234 was eliminated through backcross breeding program with resistant recurrent parent without intensive selection. Tests with S_1 plants showed combined resistance to aphid, powdery mildew, and watermelon mosaic virus I possible. Aphid resistance source L.J. 90234 was more resistant to aphids from northern California than our standard culture.

Host range of citrus stubborn disease enlarged - Riverside, California. The susceptibility to Spiroplasma citri, the citrus stubborn disease pathogen, was demonstrated in the laboratory for the vegetable crops, lettuce, New Zealand spinach, chickpea, collards, mustard greens, kohlrabi, kale, and such weed species as Sisymbrium altissimum and Descurainia sophia. Broccoli, previously infected in the laboratory and found infected in the field once, was found, in experimental plots at Riverside, to be heavily infected and damaged by S. citri and the virescence organism, transmitted by Circulifer tenellus, the leafhopper vector of the disease. Such infection suggests a potential for significant damage to broccoli and other cole crops by S. citri harbored by C. tenellus, a species found frequently on cole crops. Such reservoirs of S. citri must be considered in devising strategies for controlling stubborn disease in citrus.

Citrus blackfly parasites continue to be effective - Orlando, Florida. Twenty-eight locations in the Fort Lauderdale-Miami area were sampled to determine citrus-blackfly and citrus-blackfly-parasite activity throughout the year. Citrus blackfly occurred in trace numbers in the Fort Lauderdale sites and parasites Amitus hesperidum and Prospaltella opulenta were found active. Miami sites showed high citrus blackfly numbers in the spring, with parasite activity from late winter releases showing a rapid increase by late summer. Parasite numbers exceeded their host numbers by fall.

Intensive phony peach disease vector surveys in Georgia conducted - Byron, Georgia. Geographical distribution patterns of incriminated leafhopper vectors after 20 years were updated. Results showed that no new

suspect vector species have migrated into Georgia and geographical distribution patterns appear not to have changed drastically over the years. Primary natural vectors were correlated with phony disease incidence and with orchard cultural practices. The survey information is being used to predict vector movement and population levels in specific peach growing areas in an effort to plan effective control strategies.

Vetch as cover crop provides source for beneficial insects in pecan orchards - Byron, Georgia. The lady beetle, Hippodamia convergens (Guerin-Menville) develops in extremely large numbers on the pea aphid, Acyrthosiphum pisum (Harris), which infects vetch (Vicia spp.). Vetch is a candidate cover crop for pecan growers who wish to supplement the nitrogen supply to their trees and to improve the soil condition. In addition, vetch aids in soil moisture retention, which is affected by the thick straw mat laid down after the vetch dies. Vetch decomposes completely before pecan harvest. Vetch is also a fair honey flow crop for beekeepers and a potential seed or forage crop for growers. Several generations of H. convergens develop on vetch in the spring after which they can be made to migrate into pecan trees. There, biological control of three species of foliar feeding pecan aphids, Monellia costalis (Fitch), Monelliopsis nigropunctata (Granovsky) and Tinocallis caryaefoliae (Davis) occurs.

Low pressure soil application of carbaryl for control of weevil - Byron, Georgia. When foliar applications of insecticides are not feasible due to lack of proper equipment, poorly accessible tree location, or other factors such as small acreage production that does not justify the purpose of expensive foliar spray equipment, soil application of carbaryl may be used to provide suppression of adult pecan weevil populations. Low pressure soil surface application of carbaryl in 1978 at 2.6 lb AI/acre on a 7-day application schedule during weevil emergence gave 94% weevil-free pecans compared to 76% for the untreated plots.

Pheromones prove effective for control of peach borers in large peach orchard tests - Byron, Georgia. The mating disruption technique (permeating the air with high concentrations of synthetic pheromone) has been effective in suppressing lesser peachtree borer and peachtree borer populations by disorienting attracted males in their efforts to find females with which to mate. Following two complete seasons of evaluation, population levels have continued to decrease in the treatment orchard while populations continued to increase in the check orchard even though the check orchard received seasonal applications of insecticides for borer control.

Bulkloading, dyeing, packaging in polyethylene bags, irradiation in nitrogen, and holding for 20 hours resulted in males with sterility levels and competitiveness equivalent to males treated with the standard procedure - Honolulu-Hilo, Hawaii. Treatments of 1.3 million pupae, bulkloaded in an aluminum container and either flushed with nitrogen before and during irradiation with a minimum dose of 14 krad or backflushed briefly with nitrogen following application of a mild vacuum, resulted in males with sterility levels of 99.5% and competitiveness (ca. 50-60% of untreated males) equivalent to males treated by the standard procedure (load of 0.5 million pupae

packed in screen trays and placed in aluminum container, flushed with nitrogen before and during irradiation). Pupae in all treatments were dyed, packaged in polyethylene bags and held for 20 hours to simulate shipment conditions. This finding is important to control programs using the sterile-insect release method to suppress fruit flies. The competitiveness of irradiation sterilized flies can be enhanced by irradiation of pupae in a shipping container filled with a nitrogen atmosphere without using complicated equipment to provide continuous flow of nitrogen during the irradiation process. The operation has been simplified and made more efficient.

The cause of the droopy wing syndrome discovered - Honolulu-Hilo, Hawaii. Batches of medfly pupae were sifted in sequence at daily intervals from vermiculite pupation medium and held for eclosion. The flight ability of adults which emerged was evaluated. Pupae disturbed by sifting during the period when they were 1/3 of the way through pupal development had the most adults that were unable to fly. Hence, the so-called "droopy wing syndrome" is caused by disturbance of the pupae during wing pad formation resulting in the emergence of adults abnormal in flight ability.

Bioassay method developed to determine the quality of mass-reared fruit flies - Honolulu-Hilo, Hawaii. A bioassay procedure was developed to qualitatively evaluate the quality of pupae and adult medflies. Random samples of counted pupae were held in cages for emergence. Normal adults were permitted to fly away from a release container while those unable to fly were kept from escaping with Fluon-GP(R), a silicone material, on the vertical walls. This method is important to control programs for fruit flies where qualitative data are needed to determine pupal quality and the percentage of adults capable of flight.

A conveyor belt larval rearing system for tephritid fruit flies was developed - Honolulu-Hilo, Hawaii. A prototype conveyor belt larval rearing unit was constructed and tested. The unit incorporates features from different rearing laboratories, particularly the system used to rear the screwworm. The unit is 0.9 m x 1.5 m x 7.6 m consisting of 3 tiers of motor-driven vinyl belts, each with 3.8-cm sides. The 3 belts are spaced 22 cm apart to permit adequate ventilation for yields up to 2.2 million larvae per belt. The diet is mechanically pumped and spread (2.5 cm deep) onto the moving belt as the eggs are simultaneously sprayed with a nozzle. The conveyor belt system performed comparably to the standard rearing tray for rearing the Mediterranean fruit fly, oriental fruit fly, and melon fly. This new larval rearing system is the forerunner of a system capable of rearing 300 million or more fruit flies per week.

A new technique for collection of parasites - Honolulu-Hilo, Hawaii. Within a 24-hour period, one individual can collect several thousand parasites by exposing whole papayas infested with oriental fruit fly eggs to Biosteres oophilus females active in papaya fields and rearing the resulting parasites from oriental fruit fly larvae breeding in these papaya fruits. The new method is more efficient than the standard method of using an aspirator to collect B. oophilus parasites from papaya fruits. We now have the tools and techniques to provide a steady supply of parasites in numbers appropriate to investigate several approaches to colonization of B. oophilus

parasites and for shipments to cooperators for inoculative releases of this parasite in other locations where fruit flies are a problem. This accomplishment is important to integrated control of the medfly.

Development of an inexpensive trap - Honolulu-Hilo, Hawaii. A comparatively inexpensive trap was developed that could be used in lieu of the standard (Steiner) trap. The new trap was fabricated from available straight plastic tubing smaller than the standard trap in overall diameter and at the entrance ends. The rubber gasket and end screens are eliminated from the new design. The standard trap has tapered cylinder and entrance and must be fabricated from an extrusion model. This improved trap could become a replacement for the expensive standard trap.

The utility of blacklight traps for monitoring moth populations of the western bean cutworm has been demonstrated - Kimberly, Idaho. The monitoring program was provided to Idaho Ag. Ext. Serv. personnel during the winter of 1978-79. This development allows for timely warning to growers of the degree of damage expected and the time for most effective application of insecticides.

Mass rearing developed for striped cucumber beetle improved - Vincennes, Indiana. Development of a mesh screen container with internal support, use of Jiffy-plus mix as planting medium, selection of tolerant squash varieties as host plants, use of supplemental seeding, optimization of larval and adult rearing environments, and developing efficient and sanitary rearing procedures provide large numbers of striped cucumber beetles at relatively little expense. These improvements allow evaluation of larval rootfeeding damage on cucurbits, evaluation of control procedures, provides insects for biological studies, and support host plant resistance research.

Development of host plant resistance in fruit trees represents long-term commitment - West Lafayette, Indiana. Positive progress has been made in the identification, development, and utilization of some sources of resistance from among disease resistant apple selections. Progress in the understanding of mite resistance has also been achieved.

Nonpesticidal control of greenhouse whitefly - Beltsville, Maryland. Taking advantage of the whitefly's strong attractance to yellow-orange, a nonpesticidal control of the greenhouse whitefly was demonstrated. Fiber boards were painted with Highway yellow and then coated with a sticking agent (Tack Trap, mineral oil, or SAE90 motor oil). When suspended near infested plants, new infestations of adults were reduced to innocuous levels in a few days; established infestations required 20 to 35 days. The parasite Encarsia formosa was not attracted in numbers to the sticky traps until whitefly nymphs were unavailable.

New technique greatly improves fly control in mushroom production - Beltsville, Maryland. Incorporating diazinon into the compost greatly reduced fly-caused losses and the need for other treatments. Chemicals that produce better control than diazinon with less material and less phytotoxicity have been identified and the necessary dose levels determined.

The development and application of this compost technique could save mushroom growers several million dollars annually. In Pennsylvania alone, the sciarid fly cost mushroom growers $20.6 million in reduced yields in 1978 despite their intensive use of pesticides.

Chemical identified that attracts many pest moths to plants - Beltsville, Maryland. The volatile chemicals produced by corn silk were identified. One of these was found to attract the corn earworm and also the European corn borer, the cabbage looper, the soybean looper, and several other pest moth species. Combinations of the attractive volatile material with some of the other volatile materials increased the attraction to some species. The attractant could be used for improving insect survey techniques or as an agent in insect population suppression or in helping explain insect host plant relationships. Knowledge of the attraction chemistry could aid in developing non-attractive (and thus resistant) crop plants.

Superior soil insecticide for control of Japanese beetle larvae - Wooster, Ohio. Over a 3-year test period, Oftanol$^{(R)}$ (Amaze$^{(R)}$) has provided a consistently high degree of control of Japanese beetle larvae. With proper application, 2 years of grub control may be possible. In cooperation with the Animal Plant Inspection Service, USDA, this compound is being evaluated during 1979 at several airports. These tests will evaluate the pesticide alone and as a component in pilot pest-management programs.

Important parasite of diabrotica larvae reared - Charleston, South Carolina. Successful parasitism of the banded cucumber beetle larvae with a parasitic nematode has been accomplished in the laboratory. The parasites are now being produced in the laboratory with greater success and improvements in rearing techniques are being devised. This work could open the way for developing a national biological control program against larvae of the banded cucumber beetle and corn rootworm complex as these insects cause millions of dollars in losses yearly to such crops as sweetpotato and corn. Since there are no effective means of chemically controlling these pests, this parasite may have tremendous potential for protecting crops vital to our economy.

Reflective film mulches for insect control in vegetable crops - Charleston, South Carolina. Aluminum was the most effective mulch treatment in deterring insects and reducing insect damage. The insects affected were aphids, brown stink bugs, Diabrotica sp., and vegetable leafminers. Mosaic virus diseases were reduced in aluminum mulched squash and cucumber plants.

Fire ant natural enemy of important pest - Charleston, South Carolina. In a late season planting of cucumbers, mortality of pickleworm pupae was very high and principally due to predation by fire ant.

Studies on detecting fruit fly host plants carried out in the Hawaiian Islands - Weslaco, Texas. Color infrared aerial photographs were taken of parts of Maui, Molokai, Hawaii, and the entire island of Kauai at a scale of 1:10,000. These areas contained host plants of the Mediterranean fruit fly, oriental fruit fly, and the melon fly. Field photo maps have been made from portions of the aerial photographs and given to personnel of the Hawaiian Fruit Fly Lab for use in collection of ground truth data.

A survey method has been established using color infrared aerial photography to detect host plants of the Mediterranean fruit fly in the southern part of Mexico bordering Guatemala and the Pacific Ocean - Weslaco, Texas. An area of over one million acres was photographed at a scale of 1:10,000. Host plants such as coffee, avocado, mango, citrus, and bananas were identified from the photography. Other identifiable factors influencing Mediterranean fruit fly dispersal were land topography, land use (swamps, jungle, pasture, and cultivation), methods of transportation, dwellings, and tree planting patterns. A computerized map of the area photographed was developed to show locations of host concentrations and items affecting the dispersal characteristics of the Mediterranean fruit fly.

Kairomone activity has been found to exist between the citrus mealybug and 3 species of primary parasites - Weslaco, Texas. Three waxes removed from the mealybug were found to stimulate parasite behavior. Several solvent fractions have been isolated containing biologically active material which causes significant behavioral responses which appear to be specific for different species of parasites. The future identification of these kairomones will be a major contribution to our present knowledge of host-parasite relationships and may serve as a tool for improving integrated control programs.

Three species of ants have been found associated with citrus mealybug infestations on citrus - Weslaco, Texas. One species is capable of protecting the mealybug from natural enemies by constructing a soil enclosure over large aggregations of mealybugs on fruit and twigs on the tree. The same species of ant was also found culturing the mealybug on fallen fruit by moving the mealybug to the lower fruit surface and covering the lower half of this fruit with soil. These individual fruits were incorporated into the ant colony with numerous tunnels leading toward the main colony. Ants have also been observed in the field attacking mealybug natural enemies on the trees interfering with feeding and parasitization. Ant populations appear to be correlated with higher mealybug populations because of the protection ants provide against the mealybug's natural enemies. Control of ants by the use of pesticides is presently under investigation to determine the significance of ant interference. Ant control could provide increased beneficial insect activity which may lead to a significant reduction in the mealybug population density under an integrated control program.

A total of 5 species of primary parasites and 1 coccinellid predator of citrus mealybug were successfully collected on citrus in Florida and California and introduced into Texas - Weslaco, Texas. Three parasite species had not been previously released or recovered from this mealybug in Texas. Leptomastix dactylopii was found established five years after its initial release. Anagyrus sp. was recovered for the first time on citrus mealybug in Texas which probably resulted from an accidental introduction. Over 750,000 parasites and predators have been released over the last two years. A third parasite, Leptomastidea abnormis, has been recently colonized as a result of these releases plus numerous biotypes of other primary parasites. In the early 1970's, only one parasite, Pauridia peregrina, was recorded attacking the citrus mealybug in Texas.

Performance of laboratory-reared codling moth compared with that of natives and found less than satisfactory - Yakima, Washington. Studies over the past three years using the irradiated and unirradiated moths from four colonies reared under constant or fluctuating temperatures show that length of time in colonization is a debilitating influence on the colony and that the degree of debilitation is greater if the colony is reared under constant temperatures. In using laboratory-reared moths for field studies, it is desirable to have a moth which performs similarly to the native moths so that inferences about native populations may be drawn from the released population. It is recommended that colonies be kept not longer than 3 years at most, and preferably 2 years, and that they be reared under temperature conditions simulating those occurring in the field.

Codling moth control through mating disruption with the sex pheromone allows satisfactory biological control of the pear psylla on pears in the Pacific Northwest - Yakima, Washington. On blocks of pears treated with pheromone for control of the codling moth, effective biological control of the pear psylla was achieved where a reservoir of native parasites and predators existed. Downgrading of the fruit due to pear psylla injury was less than 1% in the pheromone-treated block and much greater in standard chemical control blocks. To establish effective biological control under commercial conditions, supplemental releases of parasites and predators must be made. Biological control of the pear psylla using native parasites and predators would result in considerable savings as control costs have been as high as $250/acre.

Low-temperature fumigation schedule for control of codling moth in cherry fruit fly in cherries for Japanese market developed - Yakima, Washington. Based on earlier research, the Japanese quarantine against importation of fresh cherries has been modified to allow the importation of U.S.-produced cherries treated with methyl bromide. The existing treatment requires fumigation at fruit pulp temperatures of 70°F or higher, which can create problems in market quality of the fruit. A schedule allowing fumigation of the fruit at temperatures as low as 40°F has been developed and has been presented to the Japanese for their consideration. Acceptance of this fumigation schedule will allow the U.S. cherry industry greater flexibility in conducting the necessary treatments and greatly assist them in shipping a high quality product to Japan. This market will have an estimated value of $4 million in 1979.

Green peach aphids controlled on potatoes by topical application - Yakima, Washington. Aldicarb (Temik(R)) and thiofanox (Dacamox(R)) gave excellent control of green peach aphid on potatoes when applied topically over small plants and lightly mixed into the soil using Lilliston cultivators. Topical application is a saving in time, money, and energy because it is applied in conjunction with the first cultivation.

Relationship between early spring weeds with alfalfa looper and western yellowstriped armyworms determined - Yakima, Washington. Early spring weed hosts such as shepherdspurse, lambsquarters, filaree, fiddleneck, or assorted mustards in and around commercial fields support early populations of alfalfa

loopers or western yellowstriped armyworms. As these weeds deteriorate or are treated with herbicides, alfalfa loopers and western yellowstriped armyworms move to pea and lentil fields. The pests on weed hosts can be surveyed to predict populations and may be controlled by spraying with insecticides.

Feeding inhibitors for Colorado potato beetle discovered - Yakima, Washington. Extracts from three species of sagebrush and several synthetic materials inhibit Colorado potato beetle larvae or adult feeding on potatoes. This beetle has developed resistance to a number of pesticides on the east coast and feeding inhibitors could be used to replace toxicants in protecting potatoes against Colorado potato beetle. These inhibitors would also be an ideal tool in developing an integrated pest management program for plant protection.

SELECTED PUBLICATIONS

Fresno, California

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National Research Program 20230

COTTON AND TOBACCO INSECTS

This National Research Program involves research to develop new and improved control practices which may be used alone or in integrated systems on a farm-by-farm or area-wide basis. Control technologies being developed include genetical methods, attractants, parasites and predators, microbial agents, insect and plant growth regulators, insecticides, cultural practices, and resistant varieties. Research is also conduced on survey methods, loss thresholds, and descriptive and predictive insect population models to develop a basis for implementing various control technologies and integrating them into total crop production systems. Application of research results will result in insect control at reduced real costs and in improved environmental quality, thus benefiting growers and consumers.

NPS Contact: R. L. Ridgway

Technological Objective 1: New and improved ecologically acceptable methods to reduce losses caused by insects and mites attacking cotton.

Research Locations:

5510 Phoenix, Arizona
5502 Tucson, Arizona
7413 Baton Rouge, Louisiana
7502 Mississippi State, Mississippi
7402 Stoneville, Mississippi
7802 Raleigh, North Carolina
7203 Brownsville, Texas
7302 College Station, Texas
7709 Florence, South Carolina

Following are some examples of recent progress:

Irradiated sotty pink bollworm strain reduced population growth in cages - Phoenix, Arizona. The ability of laboratory-reared pink bollworms to succesfully mate and to inject isozyme alleles and/or morphological mutants into a native population was demonstrated. Laboratory-reared moths carrying the dominant sooty marker were released in field cages. The sooty moths were either untreated or irradiated with 7, 10, or 20 krads of gamma radiation before release. The sooty marker was successfully incorporated into all cage populations where they were released. The proportion of the population carrying sooty depended upon the radiation treatment, as expected, and the untreated sooty releases produced as high as 50% sooty individuals in weekly

samples. Population size in the cages varied inversely with the radiation treatment of the released individuals showing the sterilized moths were having an effect upon population growth in the cages.

Attractant for an insect predator - Phoenix, Arizona. Caryophyllene ($C_{15}H_{24}$), a sesquiterpenoid, is a major component in the aroma of a cotton field. Two grams of this material in delta traps placed in cotton field caught significant numbers of green lacewings, an important insect predator. Also, beta-caryophyllene, a closely related compound, was equally attractive to green lacewings. The attractancy of caryophyllene appeared to diminish during the mid and late season, possibly due to the competition provided by the mature cotton in the field at this time. This new attractant for the green lacewing may be a useful addition to the previously known attractants.

Behavior of diapause and nondiapause pink bollworm larvae in seeking hibernation sites - Phoenix, Arizona. During July and August, mature pink bollworm larvae cut out of the bolls and drop to the soil surface to pupate. In September an increasing number of larvae remain in the bolls. By early October ca. 80% of the mature larvae can be found in the bolls. The percentage of larvae that enter diapause is higher among those that remain in the bolls as compared to those that leave bolls in early and mid-September. Thus, diapause larvae can be found in the soil, as well as in the bolls, at the end of the season. Previous information indicated that few diapause larvae remain in the bolls under southwestern desert cotton-growing conditions.

Trap developed for capturing live pink bollworm adult males - Phoenix, Arizona. A cone trap was developed that catches three times as many pink bollworm males as a currently used trap, and the males are caught alive. The trap was tested extensively in the San Joaquin Valley in the Animal and Plant Health Inspection Service sterile release program. Data obtained with live captured males crossed to unmated females at Phoenix strongly suggest that progeny from released sterile insects can be produced.

Meteorological profiles determined - Phoenix, Arizona. A tethered balloon sounding system was developed which makes possible the accurate measurement of meteorological conditions in the air from the ground up to 450 meters.

Adjuvant for improving microbial insecticides now available commercially - Phoenix, Arizona. Studies over a period of several years resulted in the development of a cottonseed flour-based adjuvant that significantly improves the efficacy of microbial insecticides. This adjuvant is now being manufactured and sold under the trademark COAX by Trader's Oil Mill Company.

New source of pink bollworm resistance in cotton found - Phoenix, Arizona. AET-5 was identified and demonstrated as a new source of resistant cotton germplasm to pink bollworm. Cotton containing AET-5 germplasm and grown in the field consistently showed less pink bollworm damage than commercial upland cotton cultivars. This material has the potential of reducing pink bollworm populations if incorporated in acceptable agronomic cotton types. AET-5 is similar in most characters to commercial cotton types.

Greater numbers of pink bollworms, Heliothis, and boll weevils found in stub cotton - Phoenix, Arizona. Ten stub cotton fields and adjacent normally planted fields were monitored throughout the season for pest and beneficial insect populations. Greater numbers of male pink bollworm moths were trapped and higher numbers of Heliothis eggs and larvae were found in stub fields than in planted fields. At 8 of 10 locations, the stub fields received 2 to 3 more applications of insecticides than in adjacent planted fields. Also, the first infestation of the Mexican strain of the boll weevil, Anthonomus grandis grandis Boheman, was recorded since stub cotton was previously grown in Arizona in 1966.

Short-season cotton escapes late-season pink bollworm infestations - Phoenix, Arizona. Short-season cotton systems to develop and mature an early crop were demonstrated to have significant impact on reducing overwintering pink bollworm populations and produce acceptable yields. If these systems can be adopted, the pink bollworm problem can be measurably reduced.

Improved lygus bug diet tested - Tucson, Arizona. An artificial gel-type diet based on dried lima beans was satisfactory for rearing lygus bugs in preliminary tests. Further development of this diet should give an improved and more economical method for rearing this insect, as compared to earlier artificial diets that required membranes to contain liquids for the bugs to feed upon, resulting in more economical production of parasites to use against the pest.

Significant parasitization of lygus bug eggs found - Tucson, Arizona. Rather high populations of lygus bug eggs found in weeds and alfalfa near Tucson, Arizona, were parasitized by a wasp, Anaphes ovijentatus, during the spring; in the fall only lygus eggs in alfalfa were parasitized. However, this parasitization was low in the mid-summer. This parasite appears to have promise for suppressing the buildup of lygus bugs on alfalfa, a source of infestation for cotton and other crops, if manipulated properly.

Yield of Leiophron uniformis increased - Tucson, Arizona. The development of a new rearing cage, the use of only mated females, and a ratio of 13 nymphs/female increased the yield of the lygus bug parasite, Leiophron uniformis, six-fold, paving the way for more efficient production of the parasite for use against this pest of vegetable, seed, fruit, and fiber crops.

Artificial diet developed for parasitic fly - Baton Rouge, Louisiana. Eucelatoria sp. is the first rapidly developing species of a parasitic tachinid fly and only the second species of tachinid to be reared to the adult stage on an artificial diet. Previously, it had been thought that fast developing species of tachinids probably could not be reared outside the host because of respiratory problems. Since Eucelatoria develops very quickly and rarely leaves the artificial diet, this is the first unequivocable evidence that a respiratory attachment is not essential for rearing parasitic tachinids on an artificial diet. This research demonstrates that most of the respiratory problems have been solved and that development of artificial diets for tachinid flies now is mainly a nutritional problem.

Improved sterile boll weevils produced - Baton Rouge, Louisiana, Mississippi State, Mississippi, and Raleigh, North Carolina. Competitiveness of males sterilized at the Mississippi Boll Weevil Research Laboratory was measured in replicated tests at several field locations. Analysis of the data showed that the competitiveness values for the acute-irradiation and the fumigation-penfluron treatments were not significantly different. However, the fumigation treatment was better than the fractionated irradiation treatment, whereas the acute irradiation treatment was not. Although the fumigation procedure appeared to be the most effective, it was rejected on the grounds that facilities did not exist that would insure safety to the operators. The competitiveness value for males sterilized by the acute irradiation-diflubenzuron treatment was ca. 0.25 (25% as competitive as untreated laboratory males).

Diet affects mating of boll weevils - Baton Rouge, Louisiana. Male boll weevils reared from the standard cottonseed meal diet did not mate nearly as readily as males reared from a cottonseed flour diet. An unidentified factor in the cottonseed meal was responsible for a 70% reduction in mating propensity. The propensity of females to mate was not affected by the larval diet, but adult diet was important. Females fed cotton squares mated more readily than females given artificial diet when paired with males reared from cottonseed meal diet. It is postulated that the diet-fed females produce less of a pheromone that normally acts over a short range to stimulate males to mate.

Improved techniques in mass rearing boll weevils - Mississippi State, Mississippi. Sand and corn cob grits, containing 2 water soluble antibiotics and 1 fungicide, were added to the surface of an insect diet. The adults which emerged were uniform, of very high quality, and had extremely low bacterial counts. In addition, the yield of adults was increased. This improvement is important to control programs requiring mass rearing of insects.

Increased capture of boll weevils in traps baited with attractant plus hop oil - Mississippi State, Mississippi. Hop oil added to traps containing the boll weevil sex attractant captured more boll weevils than traps containing only the sex attractants. Hop oil is closely related to essential oils found in cotton, but is cheaper than the cotton oils, and is commercially available.

Amino acids in boll weevil affected by bacteria - Mississippi State, Mississippi. The total amino acid content of bacterially contaminated boll weevils was decreased 20%. The neutral lipids of overwintered boll weevils decreased by over 90%, and the protein and carbohydrate decreased by 70%. Cytoplasmic virus infected boll weevils utilize more fatty acids and less glycogen for growth and metamorphosis than do normal insects.

Designs and procedures for use of boll weevil traps improved for large-scale programs - Mississippi State, Missisippi. Traps offer the most effective tool for measuring and detecting boll weevil populations while contributing as a component of control. Approximately 100,000 will be used

in various programs for the 1979 season. Extensive testing of Leggett and in-field type traps has allowed a measure of absolute capture efficiency in low level populations of weevils. The percent capture of weevils responding to the traps has been accurately measured and several improvements to increase the capture have been made.

Development of a workable scheme for biological evaluation of insect control programs - Mississippi State, Mississippi. Systematic collections of data on weather, soils, crop phenology, fertilization, insect populations, pesticide use, and yield are being made using the best techniques available. Coding systems have been developed for efficient computer storage and processing of these data. Appropriate models have been interfaced and are being validated.

Heliothis produced on early-season wild hosts result in infestations in the early stage of fruiting of cotton - Stoneville, Mississippi. Use of a sampling technique developed for quantitatively determining the density of the F_1 adult bollworm and tobacco budworm populations produced on early season wild host plants indicated that an average of 1,702 F_1 H. zea and 5,152 F_1 H. virescens adults were produced per acre of wild geranium. This is the generation that produces adults to infest cotton. A correlation between the local density of the adult F_1 populations of bollworms or tobacco budworms produced on wild host and subsequent infestation levels of larvae in adjacent cotton fields has been determined. The data indicate that local control of these early season wild hosts may have a major impact on the subsequent infestation levels in adjacent cotton.

Candidate insecticides effective against Heliothis spp. - Stoneville, Mississippi. The synthetic pyrethroids, permethrin (Ambush and Pounce) and fenvalerate, and the organophosphorus compounds sulprofos and profenofos gave good control of Heliothis in field tests. A new pyrethroid, AC-222705, shows promise of being more effective than permethrin or fenvalerate. A carbamate, UC-51762, also continued to show promise for control of Heliothis.

Sterile Heliothis hybrid behavior similar to that of the tobacco budworm - Stoneville, Mississippi. The backcross (BC) hybrid females, laboratory-reared, were equally as attractive to wild tobacco budworm males as laboratory-reared Heliothis virescens females. Wild females collected as larvae and reared on artificial diet to the adult stage displayed lower mating frequency than that of established laboratory-reared cultures of tobacco budworm or BC females; however, no difference was detected in the behavior of females reared on artificial diets versus natural hosts. The mating of BC females was synchronous with that of laboratory-reared and wild tobacco budworms. Field collections of mating pairs indicated that released BC males are able to find and mate with wild females. BC progeny from releases of BC females in semi-isolated plots of sesame was detected in two successive field generations indicating infusion of the sterile trait into wild tobacco budworm populations. Results with the BC hybrid continue to show promise as a means for suppressing tobacco budworm populations.

Sources of resistance to Heliothis and lygus bugs identified - Stoneville, Mississippi. About 100 glandless strains were evaluated for resistance to tobacco budworm larvae and tolerance to tarnished plant bugs. Fourteen strains with lowest 7-day larval weights were re-evaluated in a second larval feeding test. On the check varieties Stoneville 7A and Stoneville 7A glandless, average larval weights were 3.56 and 5.68 mg/larvae, respectively. On 4 glandless strains, La 75-73, McNair 4-1206, La 73-1, and La 75-81, average larval weights of 3.91, 4.18, 4.28, and 4.46 mg respectively were significantly lower than that for Stoneville 7A glandless but not significantly different from Stoneville 7A. Twenty strains were identified with potential tolerance to plant bugs. These results suggest significant useful genetic variability, other than gossypol, for resistance to 2 major Delta insect pests.

Data developed for biological evaluation of optimum pest management trial - Stoneville, Mississippi. The Optimum Pest Management (OPM) Trial in Panola County, Mississippi, conducted concurrently with the Boll Weevil Eradication Trial in North Carolina-Virginia began in 1978. Sixty-four fields were monitored weekly for insect data in Panola County with 20 monitored semi-weekly and 32 fields were monitored weekly in Pontotoc County with 10 fields monitored semi-weekly. Dynamic crop information such as stages of growth, fruiting, insecticide applications, petiole analysis, weather, and yields was obtained. Static information such as soil type, planting dates, cultivar, previous crop, adjacent or surrounding crops was recorded. This information is being made available to the Biological Evaluation Team for its analysis of the impact of the program on populations of the boll weevil, nontarget pest and beneficial insects and insecticide use. In addition, these data and that of subsequent years in the trial will be used to develop information on predator-prey ratios needed to give control of Heliothis spp. on cotton.

Inexpensive physical barrier dispenser devised for the boll weevil pheromone, grandlure - Raleigh, North Carolina. A polyester wrapped cigarette filter was tested as a grandlure dispenser and replaced the previously used filter-in-vial dispenser system. The cost of the new dispenser is $1.98/1000 when purchased in quantities of one million. The new dispenser was used in the Boll Weevil Eradication Trial Program in 1978. Major advantages were savings in labor required to remove and replace the filter in the glass vial, and the ease of deployment in the in-field trap.

Optical character reading (OCR) system adapted for rapid handling of biological data - Raleigh, North Carolina. An optical character reading (OCR) system of data entry was tested in 1978. An optical scanner form was designed using a combination of mark sense and OCR. Field data were entered on these forms by field personnel and later transcribed into scan areas by other personnel in the laboratory. OCR has advantages over key-punching where rapid entry is required or where large amounts of data are gathered that must be stored and accessed rapidly.

Baseline data developed on isozymes in the boll weevil - Florence, South Carolina. Electrophoretic studies of isozymes in the boll weevil have established basic data on inheritance patterns, effects of colonization on isozyme frequency, variability of isozymes between lab strains of weevils, and differences between populations from South Carolina, Arizona, and Texas. These data have the potential for providing the basis for increased precision in quality testing of weevils, maintenance of lab colonies, identification of weevils from different geographical areas, and determination of the origin of weevils.

Probability of detecting low populations of boll weevils with pheromone traps determined - Florence, South Carolina, and Raleigh, North Carolina. Cotton was planted in an isolated area and plots with 2.5 and 10 pheromone traps/ha installed. Squares with oviposition punctures by boll weevils were placed in the plots with 8 weevils/ha to simulate clumping. Capture of weevils in traps indicated that there is a 56% chance of detecting a population of this size with 2.5 traps/ha and a 95% chance with 10/ha. These data are essential to determining the number of traps needed in the trial boll weevil eradication area to insure early detection of a weevil population.

Improvements made in use of insect growth regulators against the boll weevil - Florence, South Carolina. Formulation studies indicate that quantities of oil used with diflubenzuron (Dimilin) may be reduced from 1 gal to 0.5 gal without reducing efficacy. Also, another insect growth regulator, BAY SIR-8514, appears to be equal in effectiveness to diflubenzuron.

Antibiosis character continued to show promise - Florence, South Carolina. An unknown antibiosis character present in a number of Pee Dee breeding lines (PD-695, PD-8619, and PD-875) reduces bollworm populations and therefore has the potential of reducing both tne amount of insecticide applied to cotton and the cost of producing cotton.

Fate of plant growth regulators determined - College Station, Texas. Several plant growth regulators have shown considerable promise for use in reducing insect populations. Studies with two of these growth regulators, chlorflurenol and Pennwalt TD-1123, were conducted to determine the fate of these compounds on plants and in soil. Results will be useful in designing use patterns and in identifying possible environmental hazards.

Oxidation products of virelure, a synthetic pheromone of Heliothis virescens (F.), identified - College Station, Texas. (Z)-11-hexadecenal (HDAL) and (Z)-9-tetradecenal (TDAL) each undergo oxidative decomposition to at least 8 degradation products. TDAL decomposes more rapidly than HDAL, but both undergo the same degradation sequence. Two oxidation products of each aldehyde were identified by GC/MS: (Z)-9-tetradecenoic acid and 5-tridecene from TDAL and (Z)-11-hexadecenoic acid and 5-pentadecene from HDAL. These degradation products had no effect on catches in traps baited with virgin females. In water, the half-life of TDAL was 18 h at 22°C and 50 h at 32°C. TDAL had a half-life of 9 h in soil at 22°C compared to 23 h for HDAL.

Presence of pheromone demonstrated in assassin bugs - College Station, Texas. Male assassin bugs were attracted to virgin females caged in field traps; responsiveness was maximum between 12 noon and 4 p.m. Olfactometer studies indicated overall male response to virgin and mated females was 86% and 14%, respectively. Pheromone production appeared related to female age; those 4 days old were most attractive.

New technology for production and release of egg parasite of Heliothis - College Station, Texas. In cooperation with Science and Education Administration agricultural engineers, a new method was developed by which host eggs parasitized by Trichogramma can be mass-released by air. The application equipment is compact, relatively inexpensive, and is easily installed on a standard airplane boom. In tests against heavy populations (50,000-250,000/ha) of Heliothis spp. eggs, 4 releases of parasites in 20 ha of cotton (110,000/ha per release) resulted in levels of parasitism between 85 and 100% throughout a 3-week experimental period. The new technology makes possible the uniform distribution of these parasites over large acreages of crops at carefully controlled rates of application.

Bacillus thuringiensis and Heliothis nuclear polyhedrosis virus reduces Heliothis populations and boll damage - College Station, Texas. Replicated field tests with Bacillus thuringiensis, Dipel®, and Heliothis nuclear polyhedrosis virus, Elcar®, to manage populations of Heliothis indicated treatments with microbial pesticides caused significant reductions in Heliothis larvae and significant increases in undamaged bolls.

New protein source found for boll weevil diets - Brownsville, Texas. Preliminary nutritional studies indicated that: (1) the oviposition and development diets where the blue-green algae Spirulina was used as the protein source (substituting cottonseed flour and/or nutrisoy) can be used to rear this weevil, and (2) the amino-acid-L-tryptophan increased egg laying in insects reared on diets containing fresh bananas. Weevils fed on this combination oviposited more eggs than weevils reared on diets containing tryptophan or bananas alone.

Efficiency of Heliothis pheromone trap improved - Brownsville, Texas. The wind-oriented trap was improved by removing one-half of the floor from the trap body. The improved design captured four times as many tobacco budworm males as the standard. A trap efficiency test conducted at Mante, Mexico, indicated the following efficiencies: (a) wind-oriented trap one-half floor removed, 40.8%; (b) standard wind-oriented trap, 15.7%; (c) cone trap with skirt baffle, 10.9%; and (d) standard cone trap, no baffle, 1.6%.

Precourtship behavior interrupted in the tobacco budworm - Brownsville, Texas. Tests in field plots (10-acre and 2-acre plots) indicate that successful precourtship behavior can be successfully interrupted by dispensing either major virelure component. Catches of male tobacco budworms in traps baited with living females were significantly reduced when single chemical components were dispensed 70 meters in an upwind direction. Effective dosages of 1 to 2 grams/acre/60 hours were indicated.

Flowering cycle determines relative host preference by Heliothis for cotton and pigeon pea - Brownsville, Texas. A comparison of larval investations in a 10-acre field plot strip-planted (6 X 6 rows) with cotton and pigeon pea indicated that Heliothis egg deposition closely followed the flowering cycle of both hosts. Pigeon pea did not support a population until after cotton bloom production ceased, at which time short day lengths stimulated pigeon pea to begin its flowering cycle.

Technological Objective 2: New and improved methods to reduce losses caused by insects attacking tobacco

Research Location:

7803 Oxford, North Carolina

Following are some examples of recent progress:

Selective aphicide developed for use in IPM on tobacco - Oxford, North Carolina. A highly effective IPM program has been developed on tobacco emphasizing the use of microbial agents and natural enemies. However, use of broad spectrum insecticides previously used to control sporadic outbreaks of green peach aphids on 5 to 10% of the acreage destroys natural enemies. A highly selective aphicide, pirimicarb, has been developed which can be used to control green peach aphid without destroying valuable natural enemies.

Predaceous stilt bugs successfully mass produced - Oxford, North Carolina. Approximately 120,000 tobacco hornworm moths were reared to produce 300,000,000 eggs for the production of 750,000 stilt bugs. The eggs were accumulated daily over a nine-month period and stored in a freezer until needed. The stilt bugs were released on tobacco for control of hornworms and budworms.

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National Research Program 20240

INSECT CONTROL - GRAINS, FORAGES, SUGAR CROPS, AND OILSEEDS

Technological Objective: Reduce losses in field crops by conducting research to develop new and improved control of insects and mites.

This National Research Program involves research in developing new and improved control methods, tactics, and strategies to reduce pest insect populations and losses to corn, small grains, sorghum, millets, grass and legume, forages, sugarbeets, sugarcane, soybeans, peanuts, and other field crops.

NPS Contact: Robert D. Jackson

Research Locations:

5502	Tucson, Arizona	7402	Stoneville, Mississippi
7613	Canal Point, Florida	3402	Columbia, Missouri
7702	Tifton, Georgia	5708	Bozeman, Montana
5704	Kimberly, Idaho	3416	Lincoln, Nebraska
3302	West Lafayette, Indiana	3062	Fargo, North Dakota
3407	Ankeny, Iowa	3307	Wooster, Ohio
3420	Manhattan, Kansas	7317	Stillwater, Oklahoma
7410	Crowley, Louisiana	5809	Corvallis, Oregon
7412	Houma, Louisiana	1302	University Park, Pennsylvania
1108	Beltsville, Maryland		
3508	East Lansing, Michigan	3608	Brookings, South Dakota
7502	Mississippi State, Mississippi	7315	Bushland, Texas
		5805	Yakima, Washington

Following are some examples of recent progress:

Corn:

The sex pheromones of the corn earworm and the tobacco budworm moths were identified and field tested - Tifton, GA. The full complement pheromones contained 4 and 7 components for the corn earworm and the tobacco budworm, respectively. This discovery was more than 15 years in progress. The future practical application of these materials is yet to be determined; however, the possibilities for using the materials for trapping, detection, and mating disruption and suppression in pest management programs are great.

The system for mass rearing of the fall armyworm was advanced - Tifton, GA. The development of the method to individualize eggs of the fall armyworm overcomes a primary limitation to the development of a mass rearing system for this species and its egg and egg larvae parasites. Individualized eggs can be metered either dry or in solution onto diet in rearing containers.

High clearance multiple application system for biological control materials is developed - Tifton, GA. The development of a high-clearance-conveyance system for the simultaneous application of *Trichogramma* parasitized eggs, sterile host eggs, and kairomone provides the means to enhance the development of the use of *Trichogramma* in large field plots to control insect pests.

Maysin, a flavone glycoside, was chemically identified from the silks of the corn earworm resistant cultivar Zapalote Chico - Tifton, GA. Maysin severely inhibits growth of corn earworm larvae. Resistance level by this compound is inversely related to the concentration of the compound in the silks. Final selections for corn earworm resistance were made for two newly developed yellow sweet corn inbreds which are expected to be released in the future.

Effective control of corn earworm and fall armyworm was achieved with metering the insecticide into irrigation water - Tifton, GA. The corn earworm and fall armyworm were eliminated from field, and sweet corn with Boldstar, Larvin, Sevin-4-oil, and Chlorpyrifos. Each of these were formulated to contain oil as a carrier so that it would be insoluble in the water phase for application.

This procedure of insecticide application increases the usefulness of the irrigation systems, eliminates the need for specialized equipment for insecticide application, can increase effectiveness of insecticides by increasing their coverage of the plant, and reduces the labor required to apply insecticides to crops.

Insecticides applied with irrigation equipment allows for doublecropping of corn in the southeastern U.S. - Tifton, GA. A tropical hybrid corn has been used in successful doublecropping of corn to increase the quantity of feed available for cattle, as well as increase utilization of the growing period that is available to farmers in the southeastern U.S. Doublecropping also helps prevent the development of weeds after the first crop has matured.

Several factors have been found to influence aflatoxin contamination in corn - Tifton, GA. Early planting, irrigation, and insect control tend to reduce aflatoxin in preharvest corn in experimental plots. In addition, certain corn genotypes appear to be less susceptible to *Aspergillus flavus*, and the resultant aflatoxin production than others. Therefore, good management and careful selection of corn hybrids may reduce aflatoxin contamination in corn at the time of harvest.

Corn genotype resistant to both first- and second-generation European corn borer released - Ankeny, IA. B86, an inbred line of dent corn, was released for use in corn breeding programs. This new line is highly resistant to leaf feeding by first-generation corn borers and is resistant to sheath-collar feeding by second-generation corn borer.

Corn genotype resistant to first-generation European corn borers released - Ankeny, IA. B85, derived from Pa. early synthetic, was released for use

in corn breeding programs. B85 is a relatively early maturing line and is highly resistant to leaf feeding by first-generation borers.

Efficacy of a protozoan disease for controlling the European corn borer was determined - Ankeny, IA. In general, insecticides and *Nosema pyrausta* acted independently and their effects in terms of reducing larval numbers were additive. Under field conditions, the percentage of larvae obtaining a *N. pyrausta* infection and the spore intensity of these infections did not differ significantly among the insecticide treatments and the check. Data indicate that larval reduction occurred shortly after application of *N. pyrausta* spores and also suggest that larval reduction was not dependent on spore intensity but dependent on whether or not the larvae obtained a *N. pyrausta* infection.

Criteria for timing insecticide applications for second-generation corn borers developed - Ankeny, IA. Restricted examinations of three leaves (leaf above and below the ear and ear leaf) as opposed to examining all leaves on the plant for corn borer egg masses indicated that insecticides should be applied when 30-40 percent of the plants are infested. Data suggest, however, that choice of insecticides may be as critical as proper timing. This technique will save time for corn producers and can be implemented into a pest management program for accurately predicting the need for insecticides.

Populations of insect pests and predators were greater in no-till plots than in conventional tilled plots - Ankeny, IA. Field data from two locations showed greatest numbers of black cutworm larvae, adult corn rootworms, seed corn maggots, and lady bird beetles in no-till plots, as compared to plots that were fall plowed, disked, or chiseled. Greater numbers of rootworm eggs were found between the rows than on the rows in all tillage systems. Greater numbers of European corn borer larvae and cavities were found in no-till plots; however, yield losses from dropped ears were higher in plow, disk, or chisel plots. This is an indication that pest problems will increase with reductions in tillage practices and better farm management practices will be required.

Monitoring for black cutworm populations - Ankeny, IA. Sticky traps baited with synthetic pheromone detected black cutworm adults in flight three weeks before this event was recorded by blacklight traps. Wheat bran and grape pulp were effective baits for monitoring black cutworm larval populations in preplanted fields. Bran was a most effective bait in post-planted corn fields and actually reduced black cutworm feeding on corn seedlings.

Southwestern corn borer resistant single cross corn hybrid (Mp 496 x Mp 496 x MP SWCB-1) had 70 percent less total sugars, less protein, and more fiber in the whorl tissue than did the susceptible hybrid (Ab 24 E x Mp 305) - Mississippi State, MS. These differences between genotypes may be the factors that adversely affect the Southwestern corn borer larvae which feed on the whorl tissue. Progress is continuing to be made in identifying new resistant sources and developing these into inbreds and populations resistant to leaf feeding by the Southwestern corn borer and the fall armyworm.

Reaction of commercial hybrids to infestations of Southwestern corn borer and the fall armyworm were determined - Mississippi State, MS. Sixty-seven (67) commercial hybrids were evaluated for reaction to the first and second broods of the Southwestern corn borer and the fall armyworm. There appeared to be no resistance to first brood damage in this group of hybrids. Although all hybrids showed greater damage from the fall armyworm than did the resistant check, differences among hybrids were statistically significant.

A parasite of the corn earworm has been imported - Stoneville, MS. *Apanteles kazak* was received via the Commonwealth Institute of Biological Control, European Station, and has completed four generations on *Heliothis virescens* and has been shown to be capable of developing on *Heliothis zea*.

Germplasm resistant to MDMV and tolerant to MCDV released - Wooster, OH. Corn germplasm, Oh 1 EP, was selected and released as a germplasm source of resistance to five Maize Dwarf Mosaic virus strains and high tolerance to Maize Chloridic Dwarf virus. This source of disease resistance is expected to be used by breeders for incorporation into adapted commercial varieties.

Equipment was developed and tested to dispense corn rootworm eggs uniformly in the soil - Brookings, SD. Corn plots were artifically infested with eggs of the Western corn rootworm suspended in a 0.15 percent agar solution. The eggs were dispensed 10 cm under the soil from a pressurized container mounted on a tractor. The results indicated that the artificial infestation was very uniform. These uniform low levels of infestation are useful in detecting sources of resistance when root damage ratings are used as a measurement of plant damage.

Relationship of yield reduction in corn with known numbers of corn rootworms was determined - Brookings, SD. Even under nearly ideal growing conditions 100 eggs per 0.3 meter of row caused a highly significant yield reduction (in terms of adult versus yield: fewer than one beetle per plant is capable of laying 100 eggs per 0.3 meter of row).

Small Grains and Rice:

Cereal leaf beetle resistant wheat reduces cereal leaf beetle populations - West Lafayette, IN. During the past three years, cereal leaf beetle population densities have decreased significantly in wheat fields in a 41.5 Km^2 pilot research area. The growing of resistant wheat variety accounted for savings to farmers in the research area of about 11 to 88 kg per ha. The rates of parasitism increased in the population, probably due to not using insecticides to reduce the cereal leaf beetle populations.

New genetic factors for resistance to Hessian fly in wheat - West Lafayette, IN. A newly identified genetic factor, H_9, confers resistance to all known Hessian fly biotypes. The resistance was derived from *Triticum turgidum* and has been identified on chromosome 5A, along with the H_3 and H_6 factors. It is independently inherited from the H_5 genetic factor. This research is an effort to keep ahead of the evolving biotypes and protecting the wheat crop from damage with the Hessian fly.

Hessian fly resistant wheats protect the wheat crop - West Lafayette, IN. Samples collected from more than 1,000 certified wheat fields in Illinois, Indiana, Michigan, and Ohio, showed average percent infestation in resistant varieties to be 7 percent and susceptible varieties to be 13 percent. A 20 perecent infestation level is considered to be the threshold where economic damage occurs.

Genetic control program reduces damage to wheat - West Lafayette, IN. A 1.76 q/ha increase in yield was attributed to the release of the Great Plains Biotype in a wheat field infested with native Hessian fly Biotype B, when compared to the yield of wheat infested but not protected. This research supports the hypothesis that small acreages of wheat in the eastern soft wheat region can be protected from damage through native Hessian fly by the release of the Great Plains Biotype.

Genetics of Hessian fly virulence determined for Oklahoma, Washington, and South Dakota - Manhattan, KS. Frequency of virulent biotypes were studied in Hessian fly populations collection in Oklahoma, Washington, and South Dakota. Oklahoma populations were predominantly Biotype A with low frequency of Great Plains Biotype and Biotypes B and C. Hessian fly collections from Washington and South Dakota were mainly Great Plains Biotype. No virulent biotypes (A, B, C, or D) were detected in Washington Hessian fly populations. Biotypes A and B are found at a very low frequency in South Dakota Hessian fly populations.

Resistant wheat reduces yield loss - East Lansing, MI. Under cage conditions yield losses for susceptible wheat variety 'Ionia' caused by infestations of the cereal leaf beetle were 30 percent in 1977 and 55 percent in 1978, while there was no yield loss in the resistant wheat variety 'Downy' in 1977 and only a 29 percent loss in 1978. In a field test no significant grain losses were noted in one resistant cultivar 'Downy' and two resistant germplasm releases 'Fuzz' and 'Vel;' the six susceptible cultivars, with an average larval density of 6 larvae per stem had an average yield loss of 23 percent.

One barley line found to have good resistance to the cereal leaf beetle - East Lansing, MI. Ten lines of spring barley produced from multiple parents in the second cycle of recurrent selection tested under three beetle densities in cages were significantly different from the susceptible checks. One barley line in particular was found to have good resistance. Eleven barley lines will be assigned C.I. numbers and considered for release as cereal leaf beetle resistant germplasm.

The greenbug resistant wheat variety 'Amigo' reduces losses caused by field infestations of greenbugs - Stillwater, OK. When the resistant Amigo variety was planted in field plots in comparison with the susceptible variety 'Triumph 64,' heavy losses were sustained in the susceptible plots while the resistant variety suffered little or no loss in stand counts, heads per plant, and grain per plot. In the Triumph 64 plots, stand was reduced 79 percent, heads/plant--14 percent, and grain/plot--95 percent, while reductions in the Amigo plots were stand--4 percent, heads/plant--0, and grain/plot--3 percent.

Crested wheat grass was found to be highly attractive to cereal aphids - Brookings, SD. Research on host relationships between four cereal aphid species *Schizaphis graminum, Macrosiphum avenae, Rhopalosiphum padi,* and *Rhopalosiphum maidis*, and 10 species of range grasses show that crested wheat grass was highly attractive to *S. graminum, M. avenae,* and *R. padi.* Other grasses attractive to the various aphid species included: orchardgrass and Reed Canary grass to *S. graminum; M. avenae* preferred intermediate wheat grass and creeping foxtail; and *R. padi* preferred Russian wild rye. Big blue stem and smooth brome were unattractive to the four species. *R. maidis* was not attracted to the range grasses and did not reproduce well when confined on them. This research indicates that IPM systems for controlling cereal aphids will have to include interaction between the cereal aphids and range grasses.

The effect of cereal aphid infestations on spring wheat was determined - Brookings, SD. Losses of yield of 'Protor' variety spring wheat due to infestations of *S. graminum, M. avenae,* and *R. padi* were measured in 1975, 1976, and 1977 in South Dakota. Greatest reductions in yield were caused by aphids feeding during the seedling stage; mean densities of 20 to 30 aphids per stem caused losses of 40 to 60 percent in some components of yield; aphid densities of 20 to 30 aphids per stem in the boot stage reduced components of yield 20 to 50 percent. No losses were recorded in headed grain, even at densities of 50 to 70 aphids per stem. *S. graminum* and *R. padi* were more damaging than *M. avenae* at similar densities.

Grain Sorghum and Millets:

Sorghum genotypes have been identified as resistant to the sorghum midge - Tifton, GA. Several resistant genotypes have been identified as resistant to the sorghum midge: IS 3071C, IS 1266C, IS 2579C, IS 12664C, IS 1477C, IS 2662C, IS 12564C, IS 2549C, and IS 2801C. These sources of resistance will be used to develop adapted varieties of sorghum resistant to sorghum midge.

Several lines of sorghum found to possess resistance to sorghum grain pests - Tifton, GA. When 26 grain sorghum entries were evaluated for rice weevil resistance, the average percentage of weight loss in a grain sample due to feeding damage ranged from 4 percent on FC 16205 to 52 percent on CI 171. The average number of progeny resulting from 20 adult weevils on 20 grams of seed ranged from 12 on FC 16205 to 312 on FC 8986.

Grasses and Legumes:

A new genic system and methodology found for preventing genetic vulnerability of alfalfa to virulent biotypes of aphids - Tucson, AZ. A multiclone polycross alfalfa has bene developed that will give protection against virulent biotypes of the spotted alfalfa aphid. Plants selected from a unique source by a biotype characterized as expressing the lowest degree of virulence had superior resistance to a biotype characterized as expressing the highest degree of virulence. Resistance to a slightly virulent biotype was increased from 13 to 17 percent in Lahontan variety to 87 to 95 percent in the new alfalfa. Three of the five original parent clones of Lahontan

that were classified highly resistant to a biotype 25 years ago, were still highly resistant to a biotype that is 6 times as virulent as the former.

A monograph completed on the taxonomy of a new tribe (Teruliini) of leafhoppers - Tucson, AZ. A taxonomic revision of Teruliini, a new tribe of leafhoppers in the subfamily coelidiinae, has been completed. Keys to 39 genera and 173 species are provided with description and illustration of their diagnostic features. Among 230 valid taxa, 38 genera and 131 species and subspecies are described as new to science.

Kentucky bluegrass and tall fescue lines were evaluated for antibiosis to hairy chinch bug nymphs and adults in the laboratory - Beltsville, MD. One hundred seventy-nine (179) Kentucky bluegrass P.I. lines and 62 advanced breeding lines of tall fescue were screened. Five bluegrass and two tall fescue lines demonstrated sufficient resistance to warrant further evaluation. Selections were grown in peat blocks and tested when one month old. Insects were confined on the plants within a small plastic cage sealed at the base with plaster of Paris. This method appears promising for evaluating grasses for breeding purposes and conducting detailed studies of chinch bug development on resistant selections.

Perennial rye grass cultivars demonstrate differential response to hairy chinch bugs in field trial - Beltsville, MD. Significantly fewer chinch bugs were collected from plots of 'Manhattan,' 'Pennfine,' and 'Score' at a three-way blend of Manhattan, Pennfine, and 'Yorktown,' than from 12 other cultivars. High survival of chinch bug nymphs on these cultivars and laboratory tests indicated that the field response results from preference factors which possibly influence adult acceptance for shelter and oviposition. Identification of resistant cultivars would provide an excellent means of reducing chinch bug injury in perennial rye grass.

Improved methods for mass rearing and handling of potato leafhoppers are developed - Beltsville, MD. Several thousand adult leafhoppers were reared weekly on 'Henderson' bush limabeans in a walk-in rearing room maintained at 80°F. and 15 hours light. A light box and portable cold table were used in handling the insect colonies. These methods provide a much more efficient procedure for rearing large numbers of potato leafhoppers in a short period of time than did previoulsy described methods.

Dissemination of *Rhinocyllus conicus* - Bozeman, MT. USDA-SEA scientists conducted a workshop on techniques of collection, handling, and release of *R. conicus*, an introduced weevil that feeds on thistle seed. About 30 persons from 7 Western States collected 78,000 weevils for redistribution to other States. During the past two years, 168,000 weevils have been collected which is enough to populate 336 new sites. The weevils primary host, musk thistle, is unpalatable to livestock and in the absence of the weevil, it is an aggressive invader of range and pasture. However, weevil has given up to 95 percent control of this thistle.

Development of *Nosema locustae* - Bozeman, MT. Discussions have been held between USDA and EPA to examine the potential registration of *N. locustae* for the control of grasshoppers on rangeland. After viewing available

safety and efficacy data, EPA expressed interest in expediting the registration of the product. In an effort to publicize this information and encourage potential registrants, SEA/AR published in the Federal Register a list of all data within SEA that is available for use toward registration. A package consisting of 15 scientific publications and 12 unpublished reports has been assembled and distributed to potential applicants.

Cultures of grasshopper cell lines have been established - Bozeman, MT. Through cooperative research with the University of Minnesota, cultures originally established from embryonic tissue from *Melanoplus sanguinipes* continued to grow at a slow rate, and now has been subcultured 6 times. Eight new primary cultures from embryonic tissue of *M. sanguinipes* were initiated and two are proliferating at an excellent rate.

Microsporidia continued to show promise as control agents of grasshoppers - Bozeman, MT. In experiments by Canadian cooperators using inoculum provided by the Bozeman laboratory, the desert locust, *Schistocerca gregaria*, was very susceptible to *Nosema acridophagus* in laboratory tests; in field tests on pasture, *N. locustae* caused 65 to 70 percent infection among *M. sanguinipes*, *M. packardii*, and *Cannula pellucida* at 5 weeks after treatment. Densities were reduced by only 40 percent, but egg deposition was reduced by 60 to 85 percent. In cooperative work in Argentina, *N. locustae* has been recovered from field tests that were treated 6 weeks previously. Several Argentine species are susceptible to *N. cuneatum* and *N. acridophagus*.

Release of aphid resistant red clover germplasm - Lincoln, NE. An experimental red clover composite was developed with high levels of resistance to the pea aphid and the yellow clover aphid. This red clover composite was jointly released by USDA and the Nebraska Agricultural Experiment Station as a germplasm source designated as 'N-2.' This release makes available to public and private red clover breeders a source of resistance to these two red clover pests for which resistance has not been previously available.

Sugar Crops:

Two sugarcane borer resistant varieties of sugarcane are released - Houma, LA. The selection and release of CP 70-330 and CP 70-321 to Louisiana farmers will contribute further to reductions in the amount of insecticide required to control the sugarcane borer, a severe economic pest of sugarcane in Louisiana. Results from 13 replicated outfield trials show that CP 70-321 and CP 70-330 are more resistant to sugarcane borer attack and damage than 6 of the commercial sugarcane varieties grown in Louisiana.

Planting of seed cane damage by the sugarcane borer reduces germination - Houma, LA. Planting of seed cane with 30 percent of the internodes damaged by the sugarcane borer in October 1977, reduced initial germination of the eyes 20 percent. Ninety-two (92) percent of the sugarcane borer tunnelled internodes also expressed visual symptoms of red rot infection when planted. However, stand counts in March 1978 did not indicate that red rot infection in sugarcane borer tunnels had contributed further to stand reduction.

Economic impact of aphid infestations on sugarbeets determined by the percent of viruliferous aphids - Yakima, WA. Of 350 sugarbeet plants, 178 had aphids present before the end of May, however, only 16 of these plants had virus yellows by the end of June. Economic levels of green peach aphids must be based on the percent of viruliferous aphids, number of aphids, and time of infection. Therefore, yellow trap pan catches and number of aphids per plant alone cannot be used to predict the intensity of virus yellows, and therefore, economic levels of green peach aphid.

Oilseed Crops:

Nondiapausing strain of the Mexican bean beetle found - Beltsville, MD. Two Mexican bean beetle strains, one from Maryland and one from El Salvadore were reared through their complete life cycles in the laboratory under both diapause and nondiapause-inducing photoperiods and temperatures. Adults survival and fecundity for the El Salvadore strain reared under diapause conditions was similar to that of the Maryland strain reared under nondiapause conditions. This is a first report of a nondiapausing strain of the Mexican bean beetle. If this trait could be transferred to the Maryland strain, it could provide a means of control.

System developed for mass producing eggs of the tobacco budworm for use in infesting soybean field plots - Stoneville, MS. A system has been developed for producing large numbers of tobacco budworm eggs. The use of 5,600 pupae from 18 hours of labor produces about 1.5 million eggs per week. The availability of eggs makes possible the artificial infestation of soybean plots for development of the economic treshold levels and for evaluation of effectiveness of recommended and candidate insecticides.

Effects of tobacco budworm larvae infestation on soybean yield determined - Stoneville, MS. Tobacco budworm eggs were applied in a spray to field plots of Lee-74 and Bragg soybean cultivars to establish larvae infestations. An infestation of 16 larvae per 0.3m of row from eggs applied to Lee-74 cultivar at midbloom reduced yield, but 7 larvae per 0.3m did not. An infestation of 11 larvae per 0.3m from eggs applied to Lee-74 when plots began to elongate did not reduce yield. Infestation of up to 21 larvae per 0.3m from eggs applied to Bragg cultivar at first bloom increased yield. Plants compensated for the damage by replacing the seed and increasing their weight. Infestations of 19 larvae per 0.3m from eggs applied to Bragg cultivar at midbloom did not reduce yield compared with the check. Results emphasize importance of the stage of soybean plant development in determining the need for control measures for tobacco budworms.

Heliothis spp. produced on early season wild host result in infestations in cotton and soybeans - Stoneville, MS. Use of a sampling technique developed for quantitatively determining the density of the F_1 adult bollworm and tobacco budworm populations produced on early season wild hosts indicated that a county average of 1,702 F_1 *H. zea* and 5,152 F_1 *H. virescens* adults were produced per acre of wild geranium. This is the generation that produces adults to infest cotton. A correlation between the local density of the adult F_1 populations of bollworms or tobacco budworms

produced on wild hosts and subsequent infestation levels of larvae on adjacent fields has been determined.

All recognized North American species of *Helianthus* have been collected and are being maintained - Bushland, TX. Besides being used extensively in the insect and disease resistance screening work, this material has been sent to 11 foreign countries and many locations in the U.S. All wild species are being screened for diversity of genetic characters needed to improve cultivated sunflower. Negotiations are underway for an exchange of *Helianthus* germplasm with the USSR.

Resistance to several insects found in wild species of *Helianthus* - Bushland, TX. Resistance to leafhopper, *Emboasca abrupta* was found in 7 species of *Helianthus*. Resistance to the *Masonaphis masoni* was found in 10 species of *Helianthus*. Twelve species of *Helianthus* were resistant to the carrot beetle, *Bothynus gibbosus*. Eighteen species of *Helianthus* were resistant to the sunflower beetle, *Zygogramma exclamationis*.

Timing of insecticide applications determined for sunflowers - Bushland, TX. Beginning insecticidal treatment at 15 to 30 percent bloom increased yield significantly above the yield for untreated plots. However, in plots planted in late April, beginning treatment at 20 percent bloom resulted in the highest yield and was significantly higher than the yield when treatment began at 15 percent bloom. In mid-June seeded plots, there were no significant differences among single treatments made at 20 to 60 percent bloom, however, the 20 percent bloom treatment again produced the highest yield. Control of the sunflower moth also significantly reduced head rot in sunflower to a very low incidence.

New compounds found in *Helianthus* - Bushland, TX. Two diterpenoid acids (-)-cis and (-) trans-ozic acid, were isolated from *H. occidentalis*. This is the first report of trans-ozic acid and the first report of either from *Helianthus*. These acids were not found in the sunflower hybrid 896.

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National Research Program 20250

BASIC/NON-COMMODITY RESEARCH FOR INSECT CONTROL

This National Research Program includes basic research on entomological problems regardless of the affected commodity or U.S. Department of Agriculture mission. Chemists, physiologists, ecologists, and behaviorists work together in teams to provide the in-depth fundamental knowledge needed in applied research programs in insect management.

NPS Contact: Waldemar Klassen

Technological Objective 1: Develop new and improved principles and practices of arthropod control based on the selective disruption of growth, development, and reproduction.

Research Locations:

1110 Beltsville, Maryland
3602 Fargo, North Dakota

Following are some examples of recent progress:

Boll weevil chemosterilization procedure suitable for field use - Beltsville, Maryland. Procedure for sterilizing both sexes of the boll weevil was developed. Equipment for mass sterilization of 100,000 insects was constructed and successfully field tested. Induced sterility in both sexes exceeded 99% and the insects were competitive with untreated weevils in field trials. The procedure was simple, rapid, economical, and yielded insects superior to those sterilized by irradiation. This development makes possible large-scale releases of boll weevils in control or eradication programs.

Discovery of dual localization of ecdysone 20-hydroxylase in insect cells - Beltsville, Maryland. Comparative studies of several marker enzymes demonstrated the presence of ecdysone 20-hydroxylase in both mitochondria and microsomes of tobacco hornworm midgut cells. This first demonstration of two sites for ecdysone 20-hydroxylation in a single insect tissue now permits a better understanding of the regulation of metabolic pathways for insect molting hormones and makes available improved and more specific *in vitro* assay systems for evaluating the activity and mode of action of inhibitory insect hormonal chemicals.

Six ecdysteroids present in hornworm during pupal-adult development - Beltsville, Maryland. Four were identified as ecdysone, 20-hydroxyecdysone, 20,26-dihydroxyecdysone and 3-epi-20-hydroxyecdysone and two, that have not previously been reported as naturally occurring insect molting hormones, are being characterized and assessed for biological activity. The major molting hormone present during embryonic development in the tobacco hornworm, 26-hydroxyecdysone, was not detected. The presence of six ecdysteroids from a single developmental stage of an insect provides information vital to understanding the metabolic interrelationship among these steroids and their specific functions in insects.

First synthetic steroids with brassin activity prepared - Beltsville, Maryland. Synthetic isomers of brassinolide, the recently characterized steroidal plant hormone from rape pollen, caused the typical brassin response characterized by cell elongation and cell division, resulting in curvature, swelling, and more specifically splitting of the internode in the bean second-internode bioassay. Structure-activity relationships of a number of additional synthetic brassinosteroids are being examined and sufficient quantities of the active steroids are also being prepared for evaluation of their effects on plant growth and crop production

Antimicrobial amines effective teat dips for bovine mastitis - Beltsville, Maryland. Prior *in vitro* tests demonstrated that a number of primary, secondary and tertiary amines have potent antimicrobial activity against the five species of microorganisms that cause 95% of bovine mastitis. When tested *in vivo* as teat dips certain secondary and tertiary amines were much more effective even at lower concentrations than the quaternary ammonium disinfectants currently being used, and thus offer considerable potential as safe, potent, and effective antibacterial agents for the control of bovine mastitis.

Peptide hormone extraction methods provide materials from 40 insect brains - Beltsville, Maryland. New methods for extraction and assay of oligopeptides which may act as neurohormones or neurotransmitters permit evaluation of materials in relatively few insects. This provides savings in manpower, time and rearing resources. Interferring with normal function of these peptides may provide environmentally safe control measures which could be part of an integrated pest management system.

Gut fluid color indicates developmental stage - Beltsville, Maryland. Gut fluid expressed from mature fifth instar European corn borer larvae gradually loses its color as the insect moves into the prepupal stage. Insects in diapause will not express fluid. Use of this technique permits increased precision in the non-destructive determination of the development potential of the insect.

Analytical method for encapsulated parathion formulation - Beltsville, Maryland. An analytical method was developed for determining the degree of actual encapsulation of the pesticide in the formulation. By this technique it was found that over 99% of the label concentration for ethyl parathion was inside the plastic microcapsules. This method and results are important to the safe handling of encapsulated pesticides and will permit scientists to study the effects of handling and storage on potential exposure and safety.

Structural information of insect hormone metabolites facilitated by Fourier Transform NMR - Beltsville, Maryland. The excellent sensitivity available through coherent multi-scan accumulations of pulsed, relatively weak radio signals permitted spectra of micro quantities of metabolites of 22,25-dideoxyecdysone to be obtained, pinpointing substitution at the various positions of the cholestenone skeleton. This information, in turn, was useful to collaborators in mapping out the principal metabolic pathways of this important insect molting hormone.

Residue data on three pesticides acquired for minor uses registration applications - Beltsville, Maryland. Support for the minor uses registration program was continued with the collection and submission of supervised trial data on preharvest and harvest residues of ethoprop on ten vegetables, resmethrin on three greenhouse-grown vegetables, and carbaryl on chestnuts.

Identification of candidate chitin synthesis inhibitors - Fargo, North Dakota. Studies of insect tissue culture have identified eight specific chitin synthesis inhibitors. These compounds have the potential and are being tested for control of nematodes, insects, aflatoxin-producing organisms and human pathogens.

Discovery of a new mode of action of a steroid - Fargo, North Dakota. Studies of insect cell lines have shown an immediate stimulation of membrane-bound $Na^{+}K^{+}$ ATPase by ecdysone which affects the permeability of the cell. This represents an entirely new mode of action and opens the way for the synthesis of new compounds for insect control that act specifically on insect cells.

New ovarian hormones suspected in flies - Fargo, North Dakota. Developing ovaries in house flies produce hormone(s) that regulate the release of brain hormones and stimulate the fat body to produce yolk proteins. These ovarian hormones are novel material and do not resemble any known insect hormones. Both brain hormone and yolk proteins are required by the fly to develop normal eggs. Interference with these hormones results in female sterility. Thus, this hormone system has the potential for development into a new, specific, nonpolluting insect control system.

Technological Objective 2: Develop new and improved principles and practices of insect control based on behavior and ecology.

Research Locations:

5102 Albany, California
7602 Gainesville, Florida
1100 Beltsville, Maryland
1315 Otis AFB, Massachusetts
3602 Fargo, North Dakota
0405 Dar-es-Salaam, Tanzania
5805 Yakima, Washington

Following are some examples of recent progress:

Podworm resistance factor isolated from soybean leaves - Albany, California. Podworm (Heliothis zea) is an important pest on soybeans. The larvae eat the leaves and seed pods, causing substantial damage. Pinitol, which reduces the growth of podworm larvae, was isolated from soybean leaves. The concentration of pinitol, which varies between varieties and age of leaves, may explain the nature of resistance of certain lines of soybean to podworm.

Quality assays developed for USA/Mexico Mediterranean Fruit Fly Program - Gainesville, Florida. Elimination of threatening populations of medfly from areas on and south of the border between Mexico and Guatemala is being undertaken by a joint USDA/Mexico program. Nearly one billion flies per week will be reared in southern Mexico, sterilized, and distributed over infested areas. Efficacy and efficiency of control is entirely dependent upon continuous production of behaviorally effective flies. Personnel of the Insect Attractants, Behavior, and Basic Biology Research Laboratory, together with scientists from SEA-Hawaii, APHIS, and IAEA and their Swiss consultant have devised and tested assays that promptly detect and identify deficiencies in mass-produced medflies. Simplified versions of these tests have been developed and personnel of the joint program trained in their use. There will be a continued research input into the program to meet contingencies that arise as the program becomes fully operational.

White peach scale pheromone identified and synthesized - Gainesville, Florida. The sex pheromone of the white peach scale was identified with less than 5 µg of the natural substance isolated from ca. 1 million females. The isolation and identification was accomplished with a combination of high resolution chromatographic and microspectroscopic techniques previously developed in this laboratory. The synthesized pheromone attracted large numbers of wild males of the species when it was tested in the field in competition with females. This is the second

scale insect pheromone identified and is important in increasing our basic knowledge of this group of insects of worldwide importance. In an IPM program for peaches, the white peach scale is a key member of the pest complex that must be managed, and the pheromone will facilitate detection of very low populations.

Exotic parasites show promise as control agent for fall armyworm - Gainesville, Florida. Eiphosoma vitticole is an exotic parasite of the fall armyworm which was imported into Florida from Bolivia in February 1978. Rearing procedures were developed which provide sufficient numbers of the parasite for release in south Florida, one of the few areas in the United States where the fall armyworm survives the winter. Parasite releases commenced in February 1979 and will continue through the spring. If the parasite becomes established, this would be the first step in a long-range program designed to suppress the fall armyworm population in the overwintering habitat thereby reducing the number of migrant moths invading areas farther north each spring and summer.

Pheromone traps may be useful for scheduling control measures for tobacco budworm - Gainesville, Florida. Cone-shaped traps constructed of screen-wire and baited with the tobacco budworm sex pheromone were used to monitor adult male populations throughout the 1978 tobacco growing season in Alachua County, Florida. Trap captures of male moths from the overwintered and F generations were correlated with (1) larval infestations and (2) damage levels in tobacco fields. With refinements, captures of tobacco budworm moths in pheromone traps may be used in conjunction with other scouting techniques to apply control measures to tobacco and other crops such as cotton when needed rather than on an automatic schedule.

Mating disruption shows promise for control of the corn earworm and fall armyworm in sweet corn - Gainesville, Florida. Sweet corn in Florida is treated 20-24 times per season with insecticides for control of the corn earworms and fall armyworm. (Z)-9-tetradecen-1-ol formate and (Z)-9-tetradecen-1-ol acetate effectively disrupt the mating process of the CEW and FAW, respectively, when evaporated into the atmosphere of corn fields. These materials are non-toxic to humans and other animals. When these mating disruptants are used simultaneously in conjunction with conventional control measures, recent research suggests that it may be possible to reduce the number of insecticide applications normally used for control of the CEW and FAW in sweet corn by 50% or more. This approach to insect control holds a special interest for aerial applicators because the materials are non-toxic, and they are applied at very low rates/acre (15-70 g formulated material). This allows the pilots more flying time because less time is spent in refilling spray tanks.

Cattle grubs controlled by controlled release of methoprene - Beltsville, Maryland. Implantation of pellets of poly (lactic acid) containing methoprene resulted in 90% decrease in developmental potential of the common cattle grub. The pesticide used in this technique does not kill insects while in the animal; after larvae puncture the hide they fail to pupate. However, this method does provide for reducing the reproducing population for the following season.

Corn insect ovipositional attractant in corn silk identified - Beltsville Maryland. The compound responsible for attracting females of the corn borer to lay their eggs on corn silk was identified as phenylacetaldehyde. Vapors from fresh corn silk were collected and separated by instrumental analysis into 9 components; only phenylacetaldehyde was shown to attract the corn pests in field tests. Genetic studies may make possible the development of resistant corn strains low or lacking in phenylacetaldehyde content, thus preventing larval infestation.

Novel alcohol released by male Mediterranean fruit flies identified - Beltsville, Maryland. Males of the Mediterranean fruit fly, one of the most destructive pests of citrus fruits, release a volatile mixture of chemical compounds to attract females for mating. One of these compounds was identified as l-β-fenchyl alcohol, which is known to occur in several plants but never before found in the animal kingdom. The compound was isolated from laboratory-reared males whose synthetic diet contained none of the insect's host plants, indicating that the insect is able to biosynthesize the alcohol for a specific purpose.

Chemical discovered that prevents mating of tobacco budworm moths - Beltsville, Maryland. Female tobacco budworm moths release a chemical scent which enables flying male moths to locate them for mating. Field tests conducted in North Carolina tobacco fields with several chemical compounds related in structure to that of the female scent showed that (Z)-9-tetradecenal causes the female moth to stop releasing the scent and also discourages males from approaching sexually receptive virgin females. Practical application of this compound should help to control this destructive pest through prevention and disruption of mating.

Natural attractants for the corn earworm and the tobacco budworm - Beltsville, Maryland. Analysis by gas chromatography and mass spectrometry revealed that (Z)-11-hexadecenal, (Z)-9-hexadecenal, (Z)-7-hexadecenal and hexadecenal are present on the ovipositor of the female corn earworm moth (Heliothis zea Boddie). When these chemicals were mixed in the same proportions as they occured on the ovipositor they formed an effective lure for trapping male moths. The identification of hitherto unidentified trace compounds reveals that the latter are important as components of the insect's sex attractant pheromone. Similar techniques revealed that the addition of trace components increased the attractiveness of the currently used attractant for the tobacco budworm (H. virescens), 'virelure', by a factor of 5. The attractants are important for monitoring infestations and for developing new techniques for control of these important pests of cotton, corn and other crops.

Formulation of an attractant for the screwworm fly - Beltsville, Maryland. A solid formulation using a low cost wax has been developed for the screwworm fly attractant, "swormlure-2". The unformulated attractant is a corrosive, liquid mixture with a very unpleasant odor. The soild formulation is much easier to work with and makes it possible to combine the lure with a feeding bait and an insecticide in a solid pellet. These pellets can be spread by air over large areas to reduce populations of this major pest of cattle in the southern United States and Mexico.

Simplified diet and efficient techniques reduce insect rearing costs - Beltsville, Maryland. A simplified diet and more efficient rearing techniques were developed and implemented for large scale rearing of insects of suitable quality for virus and sterile male production. By modifying existing diet formulations, selection and evaluation of various rearing containers, modifying and eliminating the need for replacement of diet during larval feeding, rearing costs have been reduced to $12-20/1000 harvested pupae or about one-fifth of previously reported costs. These developments provided an economical method for mass production of good quality insects for production of the gypsy moth virus, parasites and for pilot scale field tests of the sterile male technique.

Identification of various types of males in the field - Fargo, North Dakota. When hybrid sterility in Heliothis species is used for population suppression, an important part of the program assessment will be the collection of either adult males in traps or of larvae in the field to determine whether they are parental types (H. virescens or H. subflexa), F hybrids, or backcross generation moths. Presently, such a determination based on morphology is not feasible except for the two parental species. Work in the laboratory has produced two alternative methods to the external morphology approach to identification of unknown samples from field collection. One utilizes histological examination of testes from adult males for an accurate method of separating parental and inter-specific hybrids. The other, based on dissection and immunoelectrophoretic data from larvae, can be used to distinguish both sexes and identify the three Heliothis species (subflexa, virescens, and zea) studied so far.

Different types of sterility in Heliothis hybrid and backcross males - Fargo, North Dakota. When H. subflexa females and H. virescens males are crossed, the sons are sterile and daughters are fertile. When the daughters are backcrossed to H. virescens males, the same trend persists for many generations. Hybrid sterility seems quite promising to suppress Heliothis populations. We have found and described two different kinds of sterility in the offspring. The F and BC males are sterile because chromosomes do not stay paired in the males and reproductive cells and two-tailed sperm are formed. The BC males do not exhibit these abnormalities but they produce sperm bundles that have smaller mitochondrial derivatives and other degenerate abnormalities. Thus, in the former, spermatogenesis is abnormal; in the latter, spermatogenesis is altered.

Improved diet and rearing conditions reduce cost of insect rearing - Fargo, North Dakota. A diet with longer shelf life and resistance to fungal contamination was developed for rearing Manduca sexta. This has resulted in fewer rejected insects and increased vigor and growth rate for the colony. The diet plus exact temperature control allows the rearing of a highly synchronized colony suitable for physiological studies of homeostasis, excretion, metamorphosis, and diapause.

Control of tsetse flies with integrated program using sterile males and conventional methods - Dar-es-Salaam, Tansania. Populations of the tsetse fly Glosina morsitans morsitans were controlled with releases of laboratory-reared sterile males in a 100 square mile test plot in Tanzania. Prior to release of sterile insects the natural fly population was suppressed with two aerial applications of endosulfan. The sterile males were then released in lieu of the three to four additional sprays normally applied, reducing the insecticide usage by 60%. The released insects were highly competitive and eradication probably would have been achieved if migrant flies could have been prevented from infiltrating the test plot. The findings confirm previous results and demonstrate that the sterile insect release method is effective for tsetse fly control.

Attractive trap for the armyworm - Yakima, Washington. Populations of the armyworm, Pseudaletia unipuncta, a worldwide pest of corn, wheat, rice, and grasses have been previously monitored by light traps and aerial surveillance. These techniques are difficult and often impractical. Knowledge of the sex pheromone now makes it possible to conveniently and inexpensively monitor populations with sex attractant traps.

Improved trapping of one of the most important cotton pests, the tobacco budworm - Yakima, Washington. Convenient and long lasting formulations of the pheromone of the tobacco budworm, Heliothis virescens, one of the most important pests of cotton, have not been available. The best previously available (Hercon® strips) lasted three weeks and it was necessary to send pheromone to Herculite Corp. for preparation. A formulation using rubber septa that can be prepared by the user and that lasts for 10 weeks was developed this year.

Technological Objective 3: Develop new principles and practices in insecticide use.

Research Locations:

1103 Beltsville, Maryland
1315 Otis AFB, Massachusetts
5805 Yakima, Washington

Following are some examples of recent progress:

Two new classes of potent nematicidal chemicals - Beltsville, Maryland. Structure-activity studies on two previously reported new classes of nematicides in which other functional groups replace the amine or amide moiety have provided the most potent compounds tested to date in the Panagrellus assay, including the best commercial nematicides. Preliminary toxicity studies indicate the most active chemical of each group to be

nontoxic to rabbits at a single oral dose of 300 mg/kg. The most active chemicals are currently being tested in the greenhouse against root knot nematodes and in vivo against animal parasitic nematodes.

d-Phenothrin is effective in controlling spread of Japanese beetles by aircraft - Beltsville, Maryland. Tests in truck trailers and aircraft at Dover, AFB, Baltimore and Miami indicated that 10 g/1000 cu ft of a 10% formulation of d-phenothrin in propellants 11 and 12 was effective in preventing spread of Japanese beetles from infested areas to California and other beetle-free states. Minimizing spread of harmful insects decreases the need for control measures of all kinds.

Chemical controls of horse flies evaluated by new methods will protect people as well as livestock - Beltsville, Maryland. Methods have been developed to evaluate insecticides for controlling horse flies. Since large populations of horse flies are unavailable for routine laboratory evaluations, methods for trapping (200-2000/day) and transferring them to insecticide exposure cages have enabled scientists to conduct tests with 2-4 materials daily. The insecticides are exposed to the weather and evaluated for rate of degradation. Eventual insecticidal treatment of vegetative resting sites for horse flies should protect livestock and people in the vicinity without endangering them by direct contact with the chemicals.

Acquisition of safer, more effective insecticides from industry laboratories - Beltsville, Maryland. From January to October 1978, 20 companies submitted 47 new candidate insect control chemicals for evaluation in AR laboratories - 18 insecticides, 19 developmental inhibitors, and 10 repellents. Noteworthy was an increased emphasis on pyrethroid and growth regulator-type compounds as opposed to more conventional classes of toxicants.

Research developments reduce cost of virus production - Otis AFB, Massachusetts. Simplified and efficient procedures were developed for large scale production of the gypsy moth virus, Gypchek® . Effects of temperature, diet, method and stage of inoculation, inoculum dose, time and method of harvest and processing (extraction and purification) on virus production were determined. The data obtained was used to develop a greatly improved and highly efficient procedure for production of virus on a commercial scale. Thus, the cost, excluding overhead, of producing the final virus product was reduced to $1.80-2.40/acre equivalent or less than one-tenth of previously reported costs. This development provides a major breakthrough in the possible use of the virus for suppressing the gypsy moth.

New analytical method for the insecticide, methiocarb - Yakima, Washington. Determination of pesticide residues is often difficult because they are difficult to detect with the required sensitivity and/or because material from the crop being analyzed interferes with the analysis. A new method for determining residues of methiocarb in peas, rhubarb, raspberries, spinach, and celery has been developed which is more sensitive and less susceptible to interference from crop materials than previous methodology.

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National Research Program 20260

BIOLOGICAL AGENTS FOR PEST CONTROL

This National Research Program (NRP) describes the status and prospects for Federal research on biological control of pests and insect taxonomy in the U.S. One objective of this NRP is the exploration, evaluation, importation, and establishment of exotic natural enemies of a wide variety of pests, primarily introduced species, affecting U.S. crop production. Another objective involves two additional aspects of biological control, the augmentation and conservation of native and introduced natural enemies for control of agricultural pests. In addition, this NRP is concerned with the identification and classification of insects and mites as related to pest management and in support of research and regulatory responsibilities of Federal and State agencies and other institutions.

NPS Contact: M. D. Levin

Technological Objective 1: New and improved technology for discovery and evaluation of biological agents in foreign countries and introduction for control of insects, weeds, plant pathogens and other pests.

Research Locations:

5209	Albany, California
1213	Newark, Delaware
7602	Gainesville, Florida
1111	Beltsville, Maryland
1208	Frederick, Maryland
3402	Columbia, Missouri
7307	Temple, Texas
0203	Hurlingham, Argentina
0203	Sevres, France
0203	Sapporo, Japan
0203	Rome, Italy

Following are some examples of recent progress:

Gall fly released to control Canada thistle - Albany, California. The gall fly, Urophora cardui, was released in the United States for the first time (Idaho and California). It is hoped that the ability of this fly to cause large galls (1-2" diameter) on the stems of Canada thistle, its only host plant, will reduce the aggressiveness of this serious North American weed.

The flies released were obtained from Canadian cooperators, who have colonies already established on their Canada thistle, and from Europe, the native area of the fly. Other biological control organisms will be sought to complement the action of the fly and the previously established crown-feeding weevil, Ceutorhynchus litura, against Canada thistle.

Introductions of exotic natural enemies for biological control - Newark, Delaware. During 1978, our quarantine facility processed 238 lots of foreign insects, ca. 176,000 insects from 24 countries. A total of 72 species (449,091 specimens) left Newark and were sent in 380 shipments to 58 research workers in 28 states. From these shipments, at least 36 species of biological control agents were liberated in the USA. If these parasites and predators become established, they will make permanent and continuous reductions in damage caused by some 36 pests, including various aphids, the alfalfa blotch leafminer, Lygus bugs, the alfalfa weevil, the birch leafminer, and the larch casebearer.

Computer storage of shipment records improves quarantine operations - Newark, Delaware. A simple system of summarizing records of insect shipments from our quarantine facility was devised and is now in operation. Using a computer at the University of Delaware on a time-sharing basis, we now have quick access to essential facts concerning any shipment or release of beneficial insects which passed through our quarantine. Four years of data (1443 shipments) are now on file.

Two introduced parasites of alfalfa blotch leafminer are now established in the USA - Newark, Delaware. After five years of introducing parasites of the alfalfa blotch leafminer, an accidently introduced pest of European origin, we have now recovered in Delaware two of the most important natural enemies found in Europe. We are especially optimistic about chances for successful biocontrol in the USA because, in Europe, these two species kill about 25% of the fly puparia.

Recombinant DNA research with Bacillus popilliae and Bacillus thuringiensis - Beltsville, Maryland. A petition was submitted to the NIH Recombinant DNA Advisory Committee for approval of recombinant DNA research with entomopathogens at the P2 physical containment level.

Completion and submission of a petition for the temporary exemption from a requirement of tolerance to the Environmental Protection Agency (EPA) - Beltsville, Maryland. After three years spent in collecting data on the safety and the efficacy of the Autographa californica virus a petition was completed and submitted to EPA. The petition was immediately acquired by Sandoz Co., Homestead, Florida, who are now concentrating on producing a product, based on this virus, in preparation for full registration.

Continuous production of NPV virus in cell culture - Beltsville, Maryland. The conditions for optimum cell yield with the Spodoptera frugiperda cell line have been established in standard culture vessels. As a result of these studies a growth cycle for these cells was determined which is reproducible and can be used to reliably predict the number of cells present and their stage of growth at any specific time after inoculation of culture. This is a necessity for maximum virus production because the virus yield depends upon

the ratio of the number of cells to the amount of virus inoculated and to the stage of growth of the cells when inoculated. The precise control of these and other variables has resulted in a reduction of the cell doubling time from 24 hours to 11 hours and a 10-fold increase in virus yield. This increase in yield in the standard systems was necessary to provide the virus needed to operate the large-volume culture systems proposed.

Serological characterization of viruses - Beltsville, Maryland. The nuclear polyhedrosis viruses isolated from A. californica and from Trichoplusia ni are identical serologically, however, they behave differently when fed to different hosts and can also be differentiated by selected forms of electrophoresis.

Serum-free media for Baculoviruses - Beltsville, Maryland. Continuation of research on media requirements and optimum conditions for production of NPV in cells reared on serum-free media has been successful for the first passage of virus through the cells. This reduces the cost of media by one-helf and may lead to a method of production of viruses in tissue culture systems.

Biological control of rush skeleton weed with rust (Puccinia chondrillina) - Frederick, Maryland. Skeleton weed has become a noxious weed of concern in the Pacific northwest. California has an area of infestation of 142,000 hectares, Idaho 162,000, Oregon 1200, and Washington 1500. Effective rust strains are not yet available for an area of infestation in northeastern Washington and northwestern Idaho. The technology for mass rust inoculum increase, collection, storage and dissemination has been developed. All evidence points toward the effective use of this biological control for suppression of skeleton weed.

A fungal insecticide preparation from the USSR effective against cabbage insects in the USA - Columbia, Missouri. A mycoinsecticidal preparation of Beauveria bassiana, (Boverin), obtained from the USSR was effective in the USA against 3 pest caterpillars of cole crop (cabbageworm, diamondback moth, cabbage looper). A high rate of Boverin (5%) reduced caterpillar populations about 50% and leaf damage about 87%.

Introduced weevil (Rhinocyllus concuis) recolonized and reducing infestations of the musk thistle weed - Columbia, Missouri. This weevil, introduced in 1975, readily was established in Webster County, Missouri. Thistle populations within the original release area are declining, indicating the biological control potential of the weevil. Recolonization of the weevil in other areas of the state has been obtained.

Imported velvetbean caterpillar parasite released in Mississippi - Columbia, Missouri. Previous releases of a parasite (Euplectrus m. sp.) obtained from South America resulted in its establishment in Florida. In our attempt to duplicate the success achieved in Florida, ca. 8000 parasites were produced for release in Mississippi in 1978. Parasite recoveries representing an F1 generation have been made.

Insects found in Argentina to control weeds - Temple, Texas. Several insects and a few plant pathogens were found on mesquite, whitebrush, broomweed, creosotebush, tarbush, and locoweed in Argentina. These organisms offer much promise for controlling target weeds if introduced into the U.S.

Candidate insects found to control rangeland weeds - Hurlingham, Argentina. Promising candidate insects for introduction were found in Argentina for biological control of mesquite, broomweed, whitebrush, creosotebush, tarbush, and locoweed that are pests on rangelands of the southwestern United States.

Predacious fly from southern France established in Hawaii against Eurasian pine adelgid - Sevres, France. Following a request from the State of Hawaii the predacious fly, Leucopis obscurus was collected in France and sent to Hawaii. The latest report indicated that an average of 91.6 flies were found on 6-inch terminals of heavily infested pine trees. In France, the adelgid is limited to the very tips of the branches and an average of 5+ flies per infested terminal was found.

Alfalfa leafminer parasites from Denmark and France recently established in eastern U.S. - Sevres, France. In cooperation with the SEA quarantine laboratory at Delaware, at least 2 of a complex of species of parasites attacking Agromyza frontella in Europe have been established in the U.S. In Europe, this complex succeeds in keeping the fly population at an average of 0.4 mines per stem whereas in the U.S. control measures are considered necessary when fly populations reach 30-50 mines per stem.

Inventory of gypsy moth parasites in Europe completed - Sevres, France. With the completion of a collection of pupae in Romania, the EPL has conducted inventories or had been directly involved in similar inventories as cooperator, in France, Germany, Poland, Yugoslavia, Austria, as well as in Morocco, Iran, and Japan. The parasites obtained were sent to the U.S. as part of the Federally Funded Gypsy Moth Program.

Partial control of grain and cereal aphids in regions of Chile credited to action of European parasites - Sevres, France. An FAO request to EPL resulted in several species of aphid parasites being sent to Chile in support of an intensive biological control program started in 1976. Eventually 2 million parasites were released in various areas and resulted in the establishment of several of the introduced species. The integrated control program that has been developed has resulted in a reduction of crop loss with some of the credit for the control being attributed to the introduced parasites.

Extensive grain aphid parasite production and release program in progress in Brazil utilizing wasps of European origin - Sevres, France. Following the success in Chile, the EPL was requested to supply parasite species for a new and similar program in Brazil. In 1978, more than 60,000 parasites mass produced from French stock were released in 2 states in southern Brazil. The program was then moved north to supply parasites for central and northern grain growing states as part of an integrated control program.

Aphid predator being released - Sapporo, Japan. The aphid predator, Harmonia axyridis (Coleoptera: Coccinellidae) has been laboratory cultured and is being released in Georgia and Washington for its beneficial use against pecan aphids and pear psylla in the two states respectively. The initial culture material originated from this laboratory.

New gypsy moth parasites established - Sapporo, Japan. Parasites of gypsy moth originating from APL have successfully been cultured, released, and the first evidence of establishment in North America has been obtained for Coccygomimus disparis and possibly also for Brachymeria lasus.

Insects for use as biocontrol agents studied and shipped to U.S. for control of musk thistle - Rome, Italy. Three insect species have shown excellent potential for controlling musk thistle, Carduus nutans, in field and laboratory tests in Europe. Two species have now been approved for release in the U.S. and are being released by the USDA and University cooperators. A request for approval to release the third insect species has been submitted to an Interagency Working Group on the biological control of Weeds by a cooperator at Virginia Polytechnical University. Our Laboratory shipped 29,600 Rhinocyllus conicus, the first biocontrol agent, to the U.S. since 1970. Ten thousand five hundred and seventy nine Ceuthorhynchidius horridus, the second biocontrol agent, were shipped to BPI and an additional 1423 were sent to other laboratories. A total of 4,581 Ceuthorrhynchus trimaculatus, the third biocontrol agent have been sent to labs in the U.S. for additional testing and disease clearance. The two released insect species are already beginning to affect musk thistle densities in several widely scattered areas of the U.S. The establishment of these biocontrol agents on the weed should increase the control in areas from Virginia to the Northwest and into Canada.

Technological Objective 2: New and improved technology for increase and conservation of introduced and native biological agents for control of insects, weeds, plant pathogens and other pests.

Research Locations:

5502	Tucson, Arizona
7702	Tifton, Georgia
3102	Peoria, Illinois
1313	Orono, Maine
1110	Beltsville, Maryland
3402	Columbia, Missouri
7203	Brownsville, Texas
7302	College Station, Texas

Following are some examples of recent progress:

Recent USDA gypsy moth natural enemy importation program described - Beltsville, Maryland. There have been three periods during which exotic natural enemies of the gypsy moth have been released in the U.S., 1905-

1914, 1922-1933, and 1963 - present. Detailed descriptions of the two early importation programs have been previously published. Manuscripts have now been completed describing the recent program (to 1977). This information when published will be an essential aid for the evaulation of the eventual effects of this program.

Exotic natural enemy of adult Mexican bean beetle studied - Beltsville, Maryland. A mite ectoparasitic on adult Mexican bean beetles was discovered in El Salvador and has now been found in Honduras and Guatemala. Studies have now shown this mite to attack only the Mexican bean beetle and close plant-feeding relatives, but not the related insect-feeding ladybird beetles. Preliminary results of lab studies at Beltsville, Maryland, where the mite is now in culture, indicate a detrimental effect on the fecundity of the host beetle. This mite is the first parasite of the adult Mexican bean beetle to be studied for biocontrol. Previously studied parasites of the beetle larvae have not become established in the U.S. because the beetle overwinters as an adult.

Mammals are not susceptible to a fungal insecticide - Columbia, Missouri. No deleterious effects were observed in mice fed high doses of spores of the fungus Nomuraea rileyi and greater than 99% of the spore activity was lost during passage through the alimentary tract. Similar results were obtained for inhalation tests with rats and in eye and skin sensitivity tests with rabbits. Use of N. rileyi for controlling pest insects should not pose any serious hazards to mammals.

Insect parasites and predators reared on non-host diet - Columbia, Missouri. Two species of parasitic wasps and six species of predatory insects have been reared on diets containing no insect additives. Current rearing costs are too high to permit more wide-scale use of parasites-predators (ca. 90%+ of rearing cost is associated with rearing host insects). Successful completion of these studies could eliminate need for host insects.

A fungus (Entomophthora phytonomi) caused significant mortality of alfalfa weevil larvae - Columbia, Missouri. This fungus was first detected in 1977, killing alfalfa weevil larvae. In 1978, it was the major biotic agent significantly reducing populations of the weevil so that a first cutting of alfalfa was achieved with minimal damage without the use of pesticides.

Introduced parasites of the alfalfa weevil established - Columbia, Missouri. The larval parasite Bathyplectes anurus and the adult parasite Microtonus aethiopoides are now firmly established in Missouri. These species, in conjunction with other established biotic agents, have the potential to reduce the severity of the pest weevil.

New insecticides conserve beneficial insects while controlling pests - Columbia, Missouri. The synthetic pyrethroid fenvalerate and the carbamate UC 51762 cause minimal mortality to hymenopteran parasitoids

and hemapteran predators while controlling pest insects. Use of these compounds, together with the natural control of beneficial species in an integrated control program, could reduce the use of broad-spectrum pesticides.

Predators mechanically distribute insect virus - Columbia, Missouri. Laboratory and field-cage studies established that surface-contaminated adult predators can effectively transmit insect virus to plants for at least one week and initiate disease in cabbage loopers. These results suggest that beneficial insects can be used to initiate epizootics to regulate field populations of pest insects.

Technological Objective 3: New and improved principles and practices of insect and mite identification.

Research Location:

1111 Beltsville, Maryland

Following are some examples of recent progress:

Winter moth discovered in the United States - Beltsville, Maryland. Specimens of the winter moth were recognized in the insect collection of Oregon State University and the Oregon Department of Agriculture. This defoliator is known to be destructive to a wide array of plants, particularly rosaceous ones. Efforts are underway by the state of Oregon and APHIS-PPQ to control the infestations.

North American tussock moths defined - Beltsville, Maryland. The seven genera and 33 species of tussock moths occurring in America north of Mexico were systematically defined and characterized. Analysis of adult and larval characters led to capability to recognize the highly variable adults. Nomenclatural problems caused by inadequate specific and generic definitions and poor bibliographic research were solved, leading to a more stable nomenclature. For the first time it is possible to identify the adults of this extremely important moth family that includes the gypsy moth, Douglas-fir tussock moth, browntail moth, satin moth, and other defoliators.

Family groups of moth superfamily Gelechioidea defined - Beltsville, Maryland. A new higher classification provides for placement of the more than 20,000 species and 1,000 genera into 10 families and 28 subfamilies. Many character systems of moths representing the world's fauna were analyzed to draw conclusions leading to the definitions. This fundamental reorganization of the taxonomic framework of the superfamily will permit more accurate association of the genera and increase the predictive power inherent in the classification.

Catalog of North American beetles underway - Beltsville, Maryland. The first part of the catalog of the beetles of America north of Mexico was published. An interactive computer-based system was developed to increase the usefulness of systematic catalogs and to provide for periodic updating and to drive the printer. Basic information about correct names, distribution, and hosts of beetles is made available to the working entomological community.

Planthopper genus systematically revised - Beltsville, Maryland. The first taxonomic study of the planthopper genus Cyrpoptus was completed. Analysis of numerous character systems showed discordance and that characters of wing shape, color pattern, and size provide consistent differences for definition of the species. The leafhoppers now can be recognized. They feed on many plants, including lima beans, cotton, and pine and are potential vectors of plant diseases.

World catalog of primitive wasps completed - Beltsville, Maryland. The world fauna of 15 families of plant-feeding wasps was systematically cataloged. All published taxonomic information about these wasps was accumulated and digested to develop the catalog which provides entomologists throughout the world with information about names, geographic distribution and hosts.

Illustrated key to fruit fly genus Urophora aids biological control workers - Beltsville, Maryland. An identification key to 71 species of the fruit fly genus Urophora was devised. Analysis of numerous characters of the adults led to development of species' definitions and the ability to recognize them among undetermined specimens. Larvae of several species feed on thistles and are being studied for potential control of weed thistles. Recognition of the fly species is critical to this program and is substantially helped by the illustrated identification key.

Taxonomic revision of Neotropical fruit fly genus Rhagoletis aids in control of movement of tomatoes and potatoes in Latin America - Beltsville, Maryland. Taxonomic analysis and characterization of the 21 Neotropical species of the fruit fly genus Rhagoletis was completed. Larvae of some species are economically important pests on tomatoes and potatoes, and infested fruits or vegetables cannot enter the world market. Recognition of the species is required before appropriate control measures can be applied, and the manual provides this identification capability.

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National Research Program 20270

CROP DISEASE CONTROL AND NON-COMMODITY RESEARCH ON PLANT PATHOGENS AND NEMATODES

Technological Objective 1: Acquire fundamental knowledge and develop basic concepts relative to plant diseases, nematodes, and causal agents.

This National Research Program involves basic, fundamental research concerning plant pathogens and nematodes. Scientists seek to answer questions about the nature of resistance to diseases, how pathogens and nematodes cause damage, and how to improve existing procedures for disease and nematode control and/or management. They conduct research on the biology, morphology, genetics, virulence, and resistance mechanisms of nematodes and causal agents of plant diseases. These studies have the ultimate goal of reducing losses in agricultural production caused by diseases and nematodes.

NPS Contact: W. M. Dowler

Research Locations:

5203 Shafter, California
7706 Byron, Georgia
3311 Urbana, Illinois
7413 Baton Rouge, Louisiana
1110 Beltsville, Maryland
1208 Frederick, Maryland
3502 St. Paul, Minnesota
5708 Bozeman, Montana
1307 Ithaca, New York
7711 Charleston, South Carolina
3608 Brookings, South Dakota
7808 College Station, Texas
7313 Lubbock, Texas
5702 Logan, Utah
7619 St. Croix, Virgin Island
3507 Madison, Wisconsin

Following are some examples of recent progress:

Evaluation and development of cotton cultivars tolerant and resistant to root-knot nematode - Shafter, California. Reducing the intensity of root-knot nematode parasitism by using nematode-resistant cultivars of cotton reduced the severity of wilt caused by the Fusarium oxysporum - Meloidogyne incognita complex. Wilt reduction was in direct proportion to the amount of tolerance-resistance present as measured by the degree of nematode galling.

New detections of soybean cyst nematode - Urbana, Illinois. The soybean cyst nematode was found in 10 previously uninfested Illinois counties. An aerial survey detected 7 of the new infestations.

New subspecies of root-knot nematode described and named - Baton Rouge, Louisiana. A subspecies of root-knot nematode has been described for which no resistance in commercial soybeans exists. Some advanced lines with high resistance but poor yield have been developed which may lead to new commercial varieties. The scanning electron microscope was extremely useful in separating closely related nematode species.

Discovery of unusual fungus anatomy helps solve difficult problem in classification of mushrooms - Beltsville, Maryland. Microscopic studies of Stropharia mushroom living and preserved specimens resulted in the discovery of unusual cells distinctive for Stropharia. This is a major new aid to the classification of related species in this group which includes edible, poisonous, and hallucinogenic mushrooms.

Successful system established for computerizing information on rust fungi - Beltsville, Maryland. A system was established for computerization of fungus specimen data in the National Fungus Collections. The initial project is to computerize the fungi in the rust herbarium. When completed the system can provide information quickly and efficiently on all aspects of these important fungal pathogens.

Screening tests demonstrate field resistance of peach selections against brown rot - Beltsville, Maryland. During the past 4 years, more than 400 peach cultivars and selections were screened for field resistance against brown rot caused by Monilinia fructicola. In the field screening tests, cultivars that showed no evidence of brown rot included Camden Pekin, Rutgers Redleaf x Ranger, B-11-16-16, B-57309, FV-1459, FV-9-5, and NJ-236. Several resistant cultivars were selected for crossing to obtain germplasm for additional work.

Basic investigations completed in the classification of black-mildew fungi on conifers, grasses, and composites - Beltsville, Maryland. A third publication has been prepared on the classification of black-mildew fungi. These investigations now provide a basis for the development of monographs on Eudimeriolum and Lasiostemma.

Newly described fungus may help control an important plant pathogen - Beltsville, Maryland. Sporidesmium sclerotivorum was described as a new fungus that is parasitic on sclerotia of Sclerotinia sclerotiorum. The sclerotial state of S. sclerotiorum is a destructive pathogen of important crop plants such as lettuce, potatoes, beans, and peanuts. Therefore, the discovery and classification of a fungus that parasitizes S. sclerotiorum is a promising step in disease control.

Resistance stability to the reniform nematode - Beltsville, Maryland. A reniform nematode isolate raised on resistant cotton did not show an increased ability to reproduce on resistant cotton when compared to those raised on susceptible cotton. However, reniform nematodes raised on resistant tomato cultivars were able to reproduce better on the resistant variety than those raised on a susceptible tomato cultivar.

Ultrastructure of the reniform nematode parasitism of resistant and susceptible cotton and soybean varieties - Beltsville, Maryland. Ultrastructural studies have shown that the reniform nematode constantly secretes a structure presumed to be a feeding tube into the initial feeding cell in a root. These studies suggest the possible mechanism for infection and the resistant or susceptible reaction. The endodermis plays an important role in susceptibility or resistance and suggests that cotton may be more severely affected than soybeans under field conditions because of the elasticity of the cell walls of soybeans and their ability to keep out secondary invading organisms.

Rickettsia-like microorganism discovered - Beltsville, Maryland. A rickettsia-like microorganism was discovered in larvae of the soybean cyst nematode, Heterodera glycines, in the United States. Ultrastructural examination showed their presence in a wide range of tissues with little or no cytopathic effects. This documentation corroborates a similar finding of the microorganism found in specimens of two other genera in England and Bolivia.

Study shows increased useful range for parasite - Beltsville, Maryland. Results of a 3-year study on the probable establishment and overwintering of a mosquito mermithid in Maryland were published. It showed that the Louisiana parasite was able to establish and self-perpetuate in Maryland even though temperatures reach -19°C. After these winter conditions, the parasite killed mosquitoes the next summer at a level of 50-100% even 2 years after treatment.

Improved identification of the rye grass and oat cyst nematodes - Beltsville, Maryland. The rye grass cyst nematode (Heterodera mani), known previously in five European countries and primarily on rye grass, is extremely close to the oat cyst nematode (H. avenae), a major worldwide pest of cereals also occurring in Oregon. Present descriptions do not clearly distinguish these two forms and some workers consider them to be essentially the same. In order to make a final identification of a cyst nematode resembling the oat cyst nematode found on a grass in a pasture in California, it was necessary to study morphologically and in great detail populations of H. mani and H. avenae from various countries. As a result, the cyst nematode in California was identified as H. mani, its first occurrence in the United States and in the Western Hemisphere; and, for the first time, consistent and reliable characters to clearly distinguish these two nematodes were revealed. Thus, H. mani appears to be a valid species rather than simply a race of H. avenae.

Potential biocontrol agent of plant-parasitic nematodes - Beltsville, Maryland. Host range studies of the Bacterial Spore Parasite indicate two biotypes. One parasitized root-knot nematodes. The other parasitized root-lesion nematodes. The development of a bioassay method permits the monitoring of field plots for the presence of the spore and gives an approximation of its numbers in soil. Unfortunately, our inability to culture BSPN in vitro prevents its rapid increase in numbers for large field tests and also prevents its physiological characterization and placement among the other bacteria.

Plant host genes as potential source of viroids - Beltsville, Maryland. Molecular hybridization of pure complementary DNA complementary to highly purified potato spindle tuber viroid (PSTV) with DNA from uninfected as well as PSTV-infected tomato plants revealed the presence of unique DNA sequences complementary to PSTV in both. Fewer complementary sequences were found in DNA preparations from barley plants and none in DNA preparations from celebes ape. These results confirm and extend our previous work on the genetic origin of PSTV and suggest that PSTV may have originated in genes of normal solanaceous plants.

Formation of linear potato spindle tuber viroid (PSTV) by cleavage of circular PSTV - Beltsville, Maryland. Studies of the synthesis of PSTV indicate that circular and linear PSTV molecules are two forms of the same RNA. Linear PSTV molecules arise in vivo by cleavage of circular PSTV molecules.

Severity of cucumber mosaic virus disease reduced by CARNA 5 - Beltsville, Maryland. In tobacco, pepper, and sweet corn, cucumber mosaic virus (CMV) alone caused necrosis and death. These symptoms were reduced drastically when cucumber mosaic virus-associated RNA 5 (CARNA 5) multiplied in the presence of CMV. CARNA 5 appears to regulate disease expression in several CMV host plants.

Inoculation of plants with tobacco ringspot virus induces production of satellite virus - Beltsville, Maryland. Data show that inoculation of plants with tobacco ringspot virus (TRSV) induces the production of a satellite RNA which has little homologous similarity with the TRSV RNA. This suggests that satellite-free TRSV is capable of generating new satellite RNAs, and that the satellite is not a deletion mutant of TRSV.

Important new ecological niche for pathogens - Beltsville, Maryland. Two new mutually unrelated spiroplasma strains isolated from the nectar coated parts of flowers were found to be distinct from other known spiroplasmas. Discovery of such spiroplasmas on flower parts reveals an important unsuspected ecological niche for potentially important plant, insect, avian, or mammalian pathogens.

High-resolution stereo electron microscopy reveals true nature of unusual fracture plane - Beltsville, Maryland. Our high-resolution stereo electron microscopy techniques have clearly demonstrated that the "paracrystalline arrays of craterlike particles" found in freeze-fractured yeast preparations are really hexagonal arrays of tubes in cells prefractured during freezing at some temperature above -50°C and not as a result of fracturing at -196°C in an ultrahigh vacuum nor due to the use of "starved" yeast cells. These results emphasize the importance of high resolution stereo electron microscopy of freeze-fracture and freeze-etch preparations, the use of black versus white shadows and the potential value of fracturing specimens at -40°C when using this important technique for the study of membrane structure and function.

Two new mycoparasites of Sclerotinia were discovered - Beltsville, Maryland. Two new beneficial mycoparasites of the soilborne plant pathogen, Sclerotinia, were recently discovered from soils. The new mycoparasitic fungi are markedly similar to the recently described beneficial mycoparasite, Sporidesmium sclerotivorum, in their appearance and mycoparasitic habits. This discovery points to the existence of a previously unrecognized group of beneficial mycoparasites in soil that is responsible for the natural destruction of sclerotia, the hard, black surviving propagules of the plant pathogens. This discovery also provides two new potentially important agents for applied biocontrol technology.

Sclerotinia minor, a serious soilborne pathogen was reduced in the field by a mycoparasite - Beltsville, Maryland. Application of Sporidesmium sclerotivorum, a beneficial mycoparasite, to the field resulted in 94% reduction of sclerotia of the pathogen Sclerotinia minor that causes serious diseases on lettuce, peanuts, and other crops. This finding is significant in that it demonstrates that mycoparasitic destruction of sclerotia can proceed in field soil under natural conditions and it suggests that successful biological control of plant diseases incited by Sclerotinia spp. can be achieved by use of this mycoparasite.

Herbicides applied to soils to reduce weeds increase plant disease - Beltsville, Maryland. Addition of the cotton herbicides EPTC and prometryn at recommended rates to soils infested with Thielaviopsis, a soilborne fungus that causes cotton seedling blight, increased the disease on cotton. Cotton stand was less, and root rot was greater, in soils that received minimal field rates of the herbicides than in soils that received no herbicides. The two herbicides weakened cotton seedlings and made them more susceptible to disease. These results demonstrate that application of chemicals to control one problem may significantly increase another.

Integrated pest management reduces pickle fruit rot ("Belly Rot") in the field - Beltsville, Maryland. Field technology has been developed for integrated control of pickle fruit rot caused by the soilborne pathogen Rhizoctonia solani. The Integrated pest management approach involved normal plowing (8-9 inches deep) instead of disking, use of the biocontrol agents Trichoderma or Corticium, and very small amounts of a fungicide registered for the control of other diseases of cucumber. This breakthrough represents a considerable advance for solving the fruit rot problem, a disease for which no other control measures are known. This research will benefit not only the pickle growers, but also those of other crops afflicted by this pathogen.

Forecasting onion white rot disease appears to be possible - Beltsville, Maryland. Results obtained in the first year of a 3-year project indicate that forecasting the severity of onion white rot prior to planting the crop is a possibility. Research in commercial New Jersey onion fields has shown a positive statistical correlation between the population of the pathogen at the time of planting the crop and the severity of the disease at harvest. When perfected, such a system would be useful in an integrated pest management program to identify fields which are likely to sustain losses to white rot. This system would also identify fields which do not need pesticides to control white rot.

A natural biological control discovered in the field - Beltsville, Maryland. A natural biocontrol of damping-off of bean caused by the soilborne fungus Pythium aphanidermatum was discovered in the field. The control was expressed in two ways: (1) a light, sandy soil with poor nutrient status suppressed long-term disease development by providing poor conditions for the survival of the pathogen; (2) a darker, more nutritious soil encouraged development and multiplication of antagonistic microflora which, in turn, suppressed disease development. The microorganisms responsible for disease suppression were isolated and are being examined for their control ability. This discovery is important because it gives us the opportunity to understand how biocontrol operates in nature and to exploit the findings for developing ways to utilize the biocontrol agents.

Soybean rust resistance is a dominant factor - Frederick, Maryland. Further tests made with progeny from crosses between rust resistant and rust susceptible soybean cultivars have confirmed that specific resistance to soybean rust is a dominant factor.

Resistance to downy mildew detected in maize - Frederick, Maryland. High levels of resistance to Peronosclerospora sorghi, causal agent of downy mildew of corn and sorghum, were detected in 17 of 31 maize accessions tested from the World Downy Mildew Resistant Maize Nursery. Commercial U. S. varieties were generally very highly susceptible.

A clue to the nature of hypersensitive resistance in plant disease - St. Paul, Minnesota. Insight was gained into the nature of an important plant disease resistance mechanism. Cells of barley coleoptiles which had been grown under conditions which favored hypersensitive cell death as an expression of gene-for-gene resistance in powdery mildew were found to be subject to injury by plasmolysis. As coleoptiles aged, they became both increasingly sensitive to plasmolysis and increasingly hypersensitive to fungus attack. The results provide evidence that the mechanism for hypersensitive resistance to plant disease resides in the host's plasma membrane, and that the rate of hypersensitive cell death increases as the plasma membrane becomes less stable with age.

Mechanism identified for low receptivity to stem rust infection in the wheat variety - St. Paul Minnesota. The mechanism responsible for the reduced number of stem rust infections produced by a unit of inoculum on seedlings of Idaed 59 wheat was identified. Fungal penetrants that fail to develop into uredia were found in histological studies to cease development after the primary infection hyphae induced hypersensitive collapse of the attacked host cell. Thus, the mechanism of this resistance resembles that found in many specific resistances.

Screening method selects materials for possible useful sources of stem rust resistance - St. Paul, Minnesota. A method was tested on entries of the 1977 new wheat introductions as an initial screen of materials for potentially useful sources of resistance. The materials were sorted into groups based on seedling reaction to two racts of rust with defined avirulence to most known resistance genes and on the adult plant reaction in the field to the natural highly virulent rust population. The method greatly reduces the number of lines for which refined tests are necessary.

New system proposed for international use to identify races of oat stem rust - St. Paul, Minnesota. A new system was proposed for international use in cooperation with Canadian oat pathologists to define races of Puccinia graminis avenae. This race identification system identified 30 different races presently in North America. Identifying races by a formula system that describes combinations of avirulence and virulence provides a precise means of defining the pathogenic potential of the oat stem rust population.

New oat variety has durable resistance to crown rust - St. Paul, Minnesota. Moore, a new oat variety with resistance to crown rust, was released in 1978. The crown rust resistance was derived from a slow-rusting breeding stock in which the resistance appears to be non-specific. This protection should be more long-lasting and stable than that in any previously released oat variety.

Crown and stem rust resistances combined into a single breeding stock - St. Paul, Minnesota. Oat lines were established that possess effective resistances to both crown and stem rusts. They were derived from five multiple crosses of various combinations of six sources of stem rust resistances and five sources of crown rust resistances. These breeding stocks will simplify oat breeding programs by eliminating the need for separate breeding projects to obtain resistance to crown and stem rusts from discrete sources.

Information obtained about barley stripe disease - Bozeman, Montana. A study of the potential for outbreaks in Montana of the stripe disease of barley, caused by Pyrenophora graminea, was completed. Epidemiological studies indicated little danger to dryland barley culture and resistance was confirmed in progeny of resistant parents. These findings will help to keep P. graminea from becoming a problem in the northern Great Plains of the United States plus it will provide resistance sources to AID programs for other areas of the world where barley stripe is a serious problem now.

Bacterium found which enhances resistance to barley fungal pathogens - Bozeman, Montana. A Bacillus sp. has been found that produces metabolites antagonistic to Pyrenophora teres and to a somewhat lesser extent to several other leaf-spotting fungus pathogens of small grain cereals. In the greenhouse, application of a suspension of the bacterium to leaves of barley seedlings renders the plants highly resistant to subsequent inoculation with the net-blotch fungus. The bacterium itself is completely harmless to the barley.

New method for studying plant viruses - Ithaca, New York. Use of a new sensitive serological technique based on enzyme-linked immunosorbent assay accelerated progress and revolutionized approaches in studies of mechanisms of specificity between luteoviruses and their aphid vectors. The new procedure permitted rapid analysis of serological relationships among five vector-specific luteoviruses, allowed major improvements in diagnosis of the barley yellow dwarf disease, provided sensitive assays of virus in aphid vectors, and permitted direct identification of viruses in mixed infections. This new technique makes it possible to overcome many limiting factors in basic research with phloem-restricted luteoviruses.

New sources of resistances to Meloidogyne javanica in corn - Charleston, South Carolina. Four plant introductions of Zea mays were identified from over 400 lines screened for resistance to the root-knot nematode M. javanica. Resistance was expressed in low rates of reproduction. All of these lines were heterozygous for resistance and it is possible that the most resistant lines could be selected from inbreeding or from hybrids.

Resistance of cotton to the root-knot nematode - College Station, Texas. Considerable progress has been made in elucidating the nature of resistance of cotton to the root-knot nematode. The cotton plant can produce terpenoid aldehides in response to infection. These chemicals kill or inhibit the nematodes that encounter them. Histochemical tests for terpenoid aldehydes may facilitate and improve screening for resistance to nematodes among cotton strains.

Nematodes show specific preference for the weed silverleaf nightshade (Solanum elaeagnifolium) - Lubbock, Texas. Nematode (Nothanguina phyllobia) infective larvae aggregated toward four species of Solanaceous plants in vitro. Larvae aggregated away from five other plant species. Larvae were observed entering wounded areas of several plants; however, reproduction rarely occurs on plants other than Solanum elaeagnifolum. N. phyllobia larvae were shown to move up plant stems more than 9 cm in 12 hours. This research indicates considerable mobility by the nematode in locating host plants and infection sites on the host.

A 2-year study shows little evidence of interaction among pesticides on cotton - Lubbock, Texas. A nematicide, two herbicides, and a fungicide were applied separately and in combination on two cultivars of cotton. Nematodes and disease pressure were low both years. The most consistent effects were varietal difference and reduction of disease by the fungicide and nematicide.

Detection of nematodes and plant diseases by remote sensing techniques - Weslaco, Texas. Preliminary tests indicate that canopy temperatures of cotton were cooler in plots when nematodes were controlled by soil fumigation than in nonfumigated plots. No difference in fumigated and nonfumigated plots of citrus could be detected with IR photography.

Registration of Nevada Synthetic YY alfalfa - Logan, Utah. Nevada Synthetic YY was developed cooperatively by SEA-AR, USDA and the Nevada, Oregon, Utah, and Washington Agricultural Experiment Stations. The selection contains resistance to the northern root-knot nematode, M. hapla, the southern root-knot nematode, M. incognita, two spotted alfalfa aphid, Therioaphis maculata, and pea aphid, Acyrthosiphon pisum. Germplasm is available for incorporation into root-knot nematode and aphid resistant commercial cultivars. This will not only lead to better alfalfa cultivar selections but will be of value in areas where susceptible economically important cultivars are grown in rotation with alfalfa.

Plant protected against frost in Florida - Madison, Wisconsin. Significant protection of both tomatoes and peppers against freezing injury was obtained in southern Florida by altering the number of bacterial ice nuclei present. Large differences in ice nucleation activity were found between different pathotypes within the Pseudomonas syringae group.

Transfer of genetic information from bacteria to plants - Madison, Wisconsin. The interaction between the bacterium Agrobacterium tumefaciens and dicotyledonous plants results in a natural form of genetic engineering. The first step in the interaction is the transfer from the bacterium to the plant cell of a small portion of bacterial DNA. We have detected RNA copies of the plasmid DNA in tumor cells. Our results suggest that the RNA is a message for structural gene products. Some of these products may be replaceable thus allowing us to introduce in their place desirable genetic traits; e.g., the enhancement of seed protein quantity and quality, increased photosynthetic efficiency, and nitrogen fixation by non-legumes.

Technological Objective 2: Develop systems for economical control of plant diseases and nematodes with maximum beneficial effects on yields and quality, and with minimum undesirable effects on the environment and public health.

Scientists contributing to this technological objective are directly involved in team efforts designed to develop effective systems for crop production. They study population dynamics of nematodes and organisms which cause plant diseases so that the interaction of host and pathogen may be better understood. These systems are designed to implement the most effective combinations of improved resistant varieties, biological control, judicious use of chemicals, and cultural practices such as crop rotation. This program is in direct support of the mission and goals of the U. S. Department of Agriculture.

NPS Contact: W. M. Dowler

Research Locations:

5205	Salinas, California
5203	Shafter, California
7606	Orlando, Florida
7706	Byron, Georgia
7702	Tifton, Georgia
3311	Urbana, Illinois
7413	Baton Rouge, Louisiana
1110	Beltsville, Maryland
1208	Frederick, Maryland
3502	St. Paul, Minnesota
5708	Bozeman, Montana
1307	Ithaca, New York
7711	Charleston, South Carolina
7808	Jackson, Tennessee
7313	Lubbock, Texas
7202	Weslaco, Texas
5702	Logan, Utah

Following are some examples of recent progress:

Nematode infection adversely affects mycorrhizal stimulation of citrus seedlings - Orlando, Florida. Citrus seedlings infected with mycorrhizae and the nematode Radopholus similis were significantly smaller than seedlings infected with mycorrhizae alone.

Soil fumigation controls peach tree short life - Byron, Georgia. Preplant and annual postplant applications of DBCP (1,2-dibromo-3-chloropropane) were essential to control peach tree short life. Sodium azide and phenamiphos show some potential for controlling ring nematodes which are usually intimately associated with the short life problem.

Yields of vegetable crops were greater when nematodes and soilborne fungi were controlled with broad-spectrum biocides used in combination with film mulch and trickle irrigation - Tifton, Georgia. These practices will result in (a) increased yields, (b) lower unit production cost, (c) intensive multiple cropping, and (d) reduced input of pesticides in the soil. These data will also benefit small farmers interested in production systems for maximum yields from minimal land area.

Clean fallow and pigeon pea were more effective than millet, crotalaria, soybean and milo in suppressing root-knot nematodes on tomato transplants - Tifton, Georgia. These data will benefit growers interested in selecting summer cover crops for suppressing root-knot nematodes.

Intensive crop rotation suppressed populations of root-knot nematodes - Tifton, Georgia. A 2-year intensive cropping sequence of sweet corn-soybean-wheat-soybean-spinach suppressed numbers of root-knot nematodes. Nematodes increased rapidly on cucumber, peanuts, field corn, and southern pea. These data will result in (a) minimizing nematode damage with crop rotation in combination with resistant varieties and (b) reduced input of nematicides into the soil. These data will also benefit growers interested in selecting crop production systems for minimizing yield loss to root-knot nematodes.

Two resistant Sericea varieties reduce root-knot nematode damage in the Southeast - Tifton, Georgia. Scientists have developed germplasm that resulted in the recent commercial release of two varieties of Sericea resistant to two root-knot nematode species. Because of the resistance, plantings of these cultivars should persist longer and produce more forage than susceptible cultivars on nematode infested soil and should extend the culture of this forage legume into areas of the Southeast where it has not heretofore been grown successfully.

Aldicarb nematicide offers an efficient control of the soybean cyst nematode - Urbana, Illinois. The evaluation of aldicarb (Temik 15G) during the past three years has aided and accelerated EPA registration of this compound for use on soybeans against the cyst nematode. Band applications of aldicarb at 10.0, 13.5, and 20.0 lb/acre have increased soybean yields 18, 25, and 18 percent, respectively, in central Illinois, where alternate control practices are badly needed because no resistant varieties are presently available, and long rotations are not practical from the standpoint of the grower.

Soybean-cotton rotation aids control of reniform nematode - Baton Rouge, Louisiana. A 5-year rotation with a susceptible cotton and soybean variety and a resistant soybean variety to the reniform nematode (planted with and without soil treatment with DBCP) indicated that yield increases with the susceptible crops following a resistant crop were as much as yield increases with soil treatment. No undesirable effects on soybean oil and protein contents were detected. This information will benefit cotton and soybean farmers since they will be able to increase production by using a resistant variety in rotation without the added cost and hazards of chemical control.

Plant Disease Reporter completes another year of service to American agriculture - Beltsville, Maryland. The Plant Disease Reporter, an AR monthly scientific journal has now been serving American agriculture for more than 60 years by publishing results of applied research in plant pathology and related disciplines. It is an international journal with a circulation of about 3500 copies and is distributed to all of the 50 states and to about 90 foreign countries including many developing countries. In the United States, it is a major research tool for AR scientists, State Experiment Station workers, extension personnel, and private industry researchers. Since it does report the latest findings from applied research, the information published is frequently of direct benefit to the American farmer and ultimately to all consumers.

Systemic fungicides show potential for control of wheat stem rust - St. Paul, Minnesota. Two systemic fungicides, triadimefon and RH 2161, effectively control wheat stem rust. Comparative field trials showed that two properly timed sprays of these systemic fungicides were superior to presently available and registered protectant fungicides by preventing most of the losses incurred in severe stem rust epidemics. Thus, effective fungicides are on the shelf if severe stem rust epidemics threaten, and the economics of wheat production will support the expense of chemical control.

Nematode management reduces cost of golden nematode control - Ithaca, New York. Management systems that were developed to keep golden nematode densities below spread level have been incorporated into the APHIS program to "Reduce the population of golden nematode in the soil below the detectable level in host crop land in the United States by the end of calendar year 1985." The use of nematode management systems will reduce soil fumigation and other regulatory activities that cost over $2 million annually.

Resistant varieties offer a practical approach to solving the cyst nematode problem on soybeans - Jackson, Tennessee. Cyst nematodes are estimated to cause over $1 billion losses annually to soybean production. The nematode is known to occur in 19 states. Control with resistant varieties offers the most practical approach thus far for solving the problem.

Cotton selections show improved resistance to root-knot nematodes - Lubbock, Texas. Twelve cotton selections were made of material with the highest resistance to root-knot nematodes. Two selections appear to have nematode resistance higher than most of the commercial nematode resistant cultivars.

Aldicarb post-plant control of the sugarbeet cyst nematode, Heterodera schachtii - Logan, Utah. A good chemical control program, using 1-3 dichloropropene and aldicarb, has been developed for controlling the sugarbeet cyst nematode on sugarbeet. However, some growers fail to use a nematicide before or at-time-of-planting and their plantings are being destroyed by H. schachtii. We have developed a post-plant control method using aldicarb that partially solves this problem. The post-plant application greatly increases yields over controls and will at least return the grower his investment if not a profit.

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National Research Program 20280

WEED CONTROL TECHNOLOGY FOR PROTECTING CROPS, GRAZING LANDS, AQUATIC SITES, AND NONCROPLAND

This multidisciplinary national research program deals with the development of principles of weed science and safe and efficient practices of weed control that can be integrated with other production and protection technology into weed management systems for improving the productivity of agroecosystems. This research is essential to the development of high-yielding food, feed, and fiber agroecosystems that will maintain the Nation's food supply and improve the quality of the environment. It supports the missions and goals of SEA and the Department. This program is organized into 124 projects at 45 locations and is conducted by 62 SEA scientists in cooperation with several Federal agencies, State agricultural experiment stations (SAES), private universities and research institutes, and industrial research organizations.

NPS Contact: W. C. Shaw

Technological Objective 1.

New and improved fundamental knowledge of the biology of weeds for development of safe, new principles and mechanisms of their control by biological, chemical, cultural, ecological, physical, and integrated methods that will avoid or minimize hazards to nontarget organisms and to other components of the environment.

Research Locations:

5502	Tucson, Arizona	7402	Stoneville, Mississippi
7406	Stuttgart, Arkansas	3402	Columbia, Missouri
5102	Albany, California	1305	New Brunswick, New Jersey
5604	Denver, Colorado	1307	Ithaca, New York
7702	Tifton, Georgia	7092	Raleigh, North Carolina
3311	Urbana, Illinois	3090	Fargo, North Dakota
3302	Lafayette, Indiana	7302	College Station, Texas
1103	Beltsville, Maryland	7307	Temple, Texas
1208	Frederick, Maryland	5702	Logan, Utah
3502	St. Paul, Minnesota	5802	Pullman, Washington

Following are some examples of recent progress:

Crop selection can aid in weed management - Frederick, MD. Weed growth has been suppressed in the field by extracts of sunflower. Integrated weed management thus might benefit from inclusion of this crop in rotation with others if sunflower crop residues reduced weed growth the following year.

Extracts of hybrid sunflower break weed seed dormancy - Frederick, MD. An extract of hybrid 201 sunflower stimulated Canada thistle seed germination. The extract may contain specific chemicals that could be developed to make this important weed germinate out of season. Then it could be controlled conveniently by conventional methods or by seasonal change without interfering with crop production.

Chemical stimulates weed emergence - Frederick, MD. Broadleaf weeds are stimulated to emerge in the field by the chemical sodium azide. The emerged weeds can then be controlled by conventional techniques. Sodium azide thus could be an important chemical tool to improve weed control by converting a hidden reservoir of weed seed to a population of growing seedlings that can be selectively eliminated from the crop.

Solar irradiation reduces weed seed populations in soil under a clear plastic cover - Stoneville, MS. A simple method of utilizing solar energy may develop into a useful means of accomplishing weed seed reductions under certain circumstances. When compared to uncovered controls, significant reductions in the numbers of viable prickly sida, cocklebur, velvetleaf and spurred anoda seeds in the top 2.5 cm of soil in the field were achieved by covering the soil with clear polyethylene sheeting for one week during early August. Heat build-up in the moist soil under the sheeting from solar irradiation (maximum soil temperature exceeded 60 C on cloudless days) was the most likely reason for the reduction in viable seed numbers. More research is underway on this simple method of improving management of weed populations.

Potential competitiveness of the exotic noxious weed, itchgrass - Stoneville, MS. Itchgrass, eighteenth among the world's worst weeds, is presently limited in the United States to southern Florida and southern Louisiana. Controlled-environments research indicates that itchgrass may be expected to reach 75 to 100 percent of its maximum vegetative growth in the Gulf Coast States, the lower Midwest, the Southwest, and the South Atlantic States. Itchgrass also grows vigorously, flowers, and produces seed in controlled environments simulating growing season conditions as far north as Wisconsin. However, simulated naturally occurring chilling events in the Central and Northern United States retard the growth of itchgrass more than that of adapted varieties of corn and soybean. Therefore, itchgrass is unlikely to be a serious early season competitor with these crops outside the South.

Potential effects of global atmospheric CO_2 enrichment on weed-crop competition - Stoneville, MS. The CO_2 concentration of the atmosphere is projected to reach at least 600 ppm by 2025 A.D. In controlled-environment experiments, increasing the CO_2 concentration from 350 to 600 or 1000 ppm enhanced the growth of soybean and velvetleaf (plants with the C_3 photosynthetic pathway) more than the growth of corn and itchgrass (plants with the C_4-dicarboxylic acid photosynthetic pathway). Therefore, the projected increase in the CO_2 concentration of the atmosphere probably will result in C_3 weeds such as velvetleaf being more competitive with C_4 crops such as corn and sorghum. At the same time, the competitiveness of C_4 weeds such as itchgrass and johnsongrass with C_3 crops such as soybean and wheat may be expected to decrease.

Nitrate utilization is controlled by phytochrome Stoneville, MS. Levels of nitrate reductase (NR), the enzyme that converts nitrate to a form that can be used by plants to make amino acids, were found to be primarily controlled by the plant pigment phytochrome. Photosynthetic pigments were found to influence levels of the enzyme indirectly through control of nitrate and photosynthate levels. These results suggest that end of day light quality and degree of shading may be important in regulating the plants ability to utilize nitrate.

Glyphosate's effects are clarified by basic research - Stoneville, MS. Glyphosate greatly enhanced levels of an enzyme (phenylalanine ammonia-lyase or PAL) which converts an essential amino acid to possibly toxic compounds. Compounds which inhibit the activity of this compound slightly reversed growth-retarding effects of glyphosate. Results suggest that glyphosate exerts its effects through elimination of synthesis of certain essential amino acids and stimulation of destruction of these compounds. This research suggests specific future studies to produce glyphosate antidotes.

Chemicals that break dormancy of weed seed may improve weed control technology - Beltsville, MD. Treatments with ethanol were found to overcome dormancy in fall panicum seeds. Even a requirement for active phytochrome was completely bypassed by the ethanol treatment. A similar effect was found in seeds of witchgrass, large crabgrass, smooth crabgrass, barnyardgrass, stinkgrass, and giant foxtail. In addition to ethanol, chloroform, acetone, and methanol could also overcome some of the dormancy in fall panicum seeds. The findings suggest that the action of these substances in overcoming dormancy depend upon membrane modifying properties in a manner related to those of anesthetics. The findings have considerable impact on a broader understanding of seed dormancy and have potential for improving weed control technology.

Creeping red fescue is semi-tolerant to the herbicide glyphosate while reed canarygrass is highly susceptible - Prosser, WA. Studies with ^{14}C-labeled glyphosate have eliminated differential interception, retention, and uptake by the foliage and differential movement and degradation within the plants as selectivity factors. These results suggest a novel selectivity mechanism may be operating in creeping red fescue. This knowledge may enhance the use of fescue as a vegetative cover on irrigation ditchbanks and permit the use of herbicides to selectively control weeds without injury to fescue.

Controlled release technology improves safety and performance efficiency of herbicides - Lafayette, IN. Technology for controlled release formulations of herbicides has emerged with the development of the starch encapsulation process. It has the potential of increasing the efficacy and safety of volatile and extremely soluble herbicides applied to soils by reducing their loss into the soil and air environment. Because of their stability and residual action in the starch encapsulated granule form, these new formulations of herbicides (and other pesticides) offer safer handling for the user, maximum protection of the environment, and decrease energy and soil erosion losses by reducing soil tillage operations.

Technological Objective 2.

New and improved weed control technology for use in field crops that will increase efficiency in food, feed, and fiber production, reduce losses in yield and quality, and reduce the cost of control.

Research Locations:

7406	Stuttgart, Arkansas	3502	St. Paul, Minnesota
5203	Shafter, California	7402	Stoneville, Mississippi
5602	Fort Collins, Colorado	3090	Fargo, North Dakota
7702	Tifton, Georgia	5809	Corvallis, Oregon
3311	Urbana, Illinois	5806	Prosser, Washington
3302	Lafayette, Indiana	5802	Pullman, Washington
7412	Houma, Louisiana		

Following are some examples of recent progress:

Minimum pest management levels produce more economic returns in intensive cropping sequences - Tifton, GA. Highest annual crop yield always occur where a broad spectrum soil fumigant is used. However, certain undesirable pesticide interactions have been observed where herbicides and other pesticides such as nematicides have been applied with the soil fumigants. The economic analysis of the annual production results of intensive cropping sequences indicate that minimum pesticide usage, such as only a single herbicide with cultivation and limited insecticide applications, provide more monetary returns than maximum pesticide usage. These data indicate that optimum or minimum pesticide usage in intensive cropping sequences may result in greater economic returns of high-quality crops for growers and consumers.

Close-rows reduce weed growth and increase peanut yields Tifton, GA. In cooperative Alabama and Georgia research, peanuts grown in rows 8-inches apart reduced weights of the weed sicklepod 45 percent and increased crop yields by over 20 percent as compared to peanuts grown in standard 32-inch rows. These data will result in (a) lower threshold levels of herbicides required for satisfactory control of weeds in peanuts, (b) more economical weed control, (c) substantially higher profits, and (d) reduced input of herbicides into the environment.

Rope wick applicator offers greater precision, selectivity, and lower costs in weed control - Stoneville, MS. A herbicide applicator was developed to apply non-selective systemic herbicides in crops and pastures by selective placement of the herbicide on weeds growing above the crop plant canopy. Precise application of herbicides by the nylon rope wick reduces costs, minimizes drift and crop damage, conserves herbicide solution and provides effective control of such perennial weeds as johnsongrass in soybeans and cotton, and horsenettle and late eupatorium in grass pastures. Herbicide on the wick is replenished by capillary movement of herbicide solution from the reservoir. Sixteen manufacturers have expressed interest in making the device and have requested licenses to sell herbicide applicators based on disclosures of the U.S. Patent Application Serial NO. 969,036, entitled "Rope Wick Applicator."

Cropping-herbicide systems control red rice - Stuttgart, AR. Crops rotated with rice and treated with specific herbicide-mechanical practices, reduce red rice infestations on land contaminated with this weed. Two-years of soybeans, treated with preplant alachlor, metolachlor, trifluralin, profluralin, fluchloralin, fluchloralin + metribuzin, alachlor + metribuzin, alachlor + trifluralin, trifluralin + metribuzin, or profluralin + metribuzin, controlled red rice when combined with cultivation and postemergence

directed sprays of paraquat. A system of grain sorghum-soybeans-rice also controlled red rice. Effective herbicides for grain sorghum include preplant propazine, postemergence atrazine or postemergence directed paraquat. After grain sorghum, soybeans treated with effective herbicides are grown; then rice is grown in the third year. Red rice can be reduced in the rice crop by herbicide-cultural-water management treatments -- preplant molinate followed by water-seeding and combined with continuous flooding.

Pathogen controls northern jointvetch in rice - Stuttgart, AR. An endemic fungus consistently controlled northern jointvetch in rice and soybean fields in a five-year research program. This fungus is specific for northern jointvetch. It does not injure rice, soybeans, or nontarget crops. It is safer to use on rice and soybeans and nearby nontarget crops than standard phenoxy herbicides. It can be used as a partial substitute for 2,4,5-T and silvex. The next step is registration and use of the first bioherbicide for selective weed control in intensively cultivated crops.

New herbicide evaluated for weed control in sugarcane - Houma, LA. Hexazinone was found highly effective for the preemergence control of johnsongrass seedlings and most annual weeds in sugarcane. Sugarcane tolerance to the herbicide was influenced by soil type and the sensitivity of individual sugarcane cultivars. Sugarcane generally was not injured on fine-textured clay loam and clay soils but injury was observed on coarse-textured silt loam soils. Research indicates that hexazinone will be most useful in mixtures with other herbicides.

Diclofop kills some types of volunteer corn cultivars better than others - St. Paul, MN. Not all volunteer corn is equally susceptible to diclofop, a new herbicide that selectively kills volunteer corn in soybeans. Volunteer corn from 240 corn hybrids was evaluated for control by diclofop. Controlling the more tolerant types will require higher rates of application and closer attention to the timing of the applications. A North Central Region publication giving the results of these studies will be released in February 1979 to aid growers in using this new herbicide. Registration of diclofop for this use is pending.

Difficult to rid the soil of weed seeds - St. Paul, MN. The soil reservoir of velvetleaf and wild mustard seeds was not eliminated by four years of periodic stirring of the soil with tillage implements. Even though this practice reduced the population to 7 percent of that originally present, there remained 80 to 90 seeds per square foot. Under continuous cropping with alfalfa or bromegrass, approximately 50 percent of the seeds remained even though no production of new seeds was allowed. These studies demonstrate the extreme difficulty of ridding a field of a weed infestation and suggest the importance of having suitable control methods available, of preventing the spread of weeds by unclean crop seeds, and of preventing the introduction of new weeds from foreign sources.

Improved germination procedures allow better selection of seed lots - Urbana, IL. Herbicides are sometimes blamed for injury to crops that may actually be caused or accentuated by lots of seed with poor vigor. Several germination tests, including warm tests and cold tests, were conducted on various seed lots and correlated with field performance. The cold test

was found to be the best one for identifying seed lots that will perform well in the field and should be more helpful than the standard warm germination test in identifying problem seed lots.

Develops guidelines for use of desiccants to accelerate soybean harvest - Urbana, IL. Research has demonstrated that ametryn, paraquat, and glyphosate can be used to desiccate soybeans and speed-up harvest, without reducing yields, if applications are made no earlier than 2 weeks before soybean maturity. These treatments can be helpful in reducing harvest delays and losses due to weed growth and adverse weather.

Incorporation studies provide guidelines for use of tillage equipment to incorporate herbicides into the soil. Urbana, IL. Research data over several years and locations provides definite guidelines to producers about the mixing characteristics of several tillage tools. Comparative data are made available to growers regarding large and small disks, field cultivators, and other types of tillage equipment. These guidelines allow the producer to use herbicides more effectively.

Weed seed decline in irrigated soil - Fort Collins, CO. After three cropping years, the greatest depletion in the total number of weed seeds in soil has occurred in continuous corn plots as opposed to a sugarbeet-barley-corn rotation. The total number of weeds per hectar in the continuous corn plots has decreased by an average of 66 percent compared to an average of 48 percent in the rotational cropping systems. This was accomplished by applying effective herbicides and integrating effective cultural practices. Based on weed seed decline counts, we should be able to predict which weed species will be the most prevalent in soil. This information should enable a farmer to select the appropriate crop for the next growing season and the cultural practices that would maximize weed control, minimize the excessive use of herbicides, and optimize crop production.

Improved method for weed control in alfalfa - Prosser, WA. Subsurface line injection of EPTC concurrently with seeding of alfalfa in rows for seed production controlled annual grasses and certain broadleaf weeds effectively. In the usual procedure that has been used for 19 years, EPTC is sprayed, then incorporated (one or two operations), and the seed is planted, for a total of up to four equipment trips over the field. With the new method, the EPTC is injected into the soil as two lines 5 cm deep and 6 cm apart in the same operation that the seed is sown. A band of weed control about 12 cm wide on which the alfalfa grows results. Weeds between the rows are controlled by cultivation. Those broadleaf weeds that survive the soil treatment are effectively controlled by postemergence applications of 2,4-DB. Inputs of time, energy, machine use, and herbicide are reduced without sacrificing weed control or crop safety while net profits are increased.

New method discovered for applying herbicides for weed control in alfalfa and field beans - Prosser, WA. Excellent control of annual grass weeds without significant crop injury resulted when the herbicide EPTC was applied in a porous coating directly to the seed of alfalfa and field beans. When these herbicide-treated seeds were planted in rows, weeds were controlled in bands 5 to 10 cm wide on which the crop rows were centered. This novel method had not been tried previously because it had been assumed

that crops would be injured if such high concentrations of herbicides were applied to the seeds. The new method opens many possibilities for efficient and economical weed control in alfalfa, beans, and other crops. The one operation of planting the herbicide-treated seed accomplishes that which traditionally required up to four separate operations.

A compact soil-driven herbicide incorporator-planter was developed - Shafter, CA. Based on data collected over two years, this unit offers much promise for the incorporation of herbicides at time of cotton planting. The unit is no larger than a standard cotton planter. Because of band application, the system would reduce the herbicide amount by 50 percent thus reducing herbicide cost and the potential for residue damage to subsequent crops. Since the incorporating equipment is firmly fixed to the planting equipment, precision placement of herbicides is greatly improved.

Supplementing cultivation with DSMA improves yield of cotton - Shafter, CA. Although supplementing cultivation with DSMA for the control of johnsongrass increased the yield of cotton 20 percent, yield losses from johnsongrass were 40 percent more than weed-free plots. Yield losses were attributed to both injury from the herbicide and the vigorous regrowth of the johnsongrass that occurred after treatment. The study indicates that although progress has been made in controlling johnsongrass, more effective treatments are needed to prevent yield losses from this weed.

Reduced tillage enhances the growth of spring planted crops and reduces energy requirements and soil erosion - Pullman, WA. Spring wheat and spring barley were grown successfully for two seasons with no-till planting. Weeds were controlled successfully and economically with commercially available herbicides. Crop yields were equal or higher than on adjacent tilled seedbeds. The increased yield potential with no-till planting is a result of improved water conservation (soil and surface residues are not disturbed) and earlier planting (seedbed does not have to be prepared). Besides the potential for higher yield and energy conservation, no-till planting may allow for more spring cropping in the now traditional fallow areas. Less fallow would reduce tillage energy requirements, costs, and total soil erosion in these areas.

New herbicide registration will allow extended use of the chemical seedbed techniques when establishing grasses for seed -Corvallis, OR. Results and data generated by this project helped obtain the recent EPA registration for use of glyphosate in grass seed fields. This registration will allow growers to plant a cover crop in the fall to prevent winter wind and/or water erosion, kill the cover crop with glyphosate in the spring, and plant grass seed crops without tillage. Thus, benefits of the chemical seedbed technique developed to control weed grasses in grass plantings can be extended to many additional fields where soil erosion has prevented its use in the past.

Effective wild oat control systems demonstrated in pilot project - Fargo, ND. Wild oat seed reserves, in heavily infested fields, can be reduced up to 90 percent in one year with currently available practices to give nearly complete wild oat control. These practices include fallow, soybean cropping practices, and triallate + barban application on small grains. The complete elimination of a wild oat seed reserve was not possible,

however, and continued control measures may be warranted if long-term effects of reinfestation are considered. Effective wild oat control in U.S. small grain production can result in an estimated annual production and cost benefit of $150-200 million.

Technological Objective 3.

New and improved weed control technology for use in horticultural crops that will increase production efficiency, reduce losses in yield and quality, and the cost of control.

Research Locations:

7702	Tifton, Georgia	7711	Charleston, South Carolina
1103	Beltsville, Maryland	7202	Weslaco, Texas
1208	Frederick, Maryland	5806	Prosser, Washington
1305	New Brunswick, New Jersey		

Following are some examples of recent progress:

New chemical tools are provided to the horticulturist - Frederick, MD. Oxadiazon is now registered for control of yellow woodsorrel in greenhouse grown roses. Roses are a very high value crop with annual sales estimated in excess of $20 million. Production has been severely hampered by yellow woodsorrel. This herbicide will reduce the costs for control and increase rose production, resulting in an increase in crop value of up to 10 percent.

New herbicide controls weeds in cranberry bogs - New Brunswick, NJ. Glyphosate was applied to tall weeds in cranberry bogs at various times during the growing season using the endless belt wiper. It was found that the best weed control was obtained when glyphosate was applied in mid-summer after the weeds had made good growth. Excellent weed control was obtained using this method of application with no injury to the cranberry vines.

Development of weed control practices in container-grown ornamentals - Tifton, GA. Research data was supplied through USDA to IR-4 on research on herbicides for weed control in container-grown ornamentals. Fourteen ornamental species were used in the evaluation and six chemicals at four rates were evaluated. Data on weed control, weed species present, marketability of plants, foliage, and root injury were presented. These data will be used by the IR-4 committee to obtain registered herbicide uses through the cooperating companies on these container-grown species.

Center pivot irrigation effectively used to apply a wide range of pesticides - Tifton, GA. Center pivot irrigation systems, capable of applying 0.25 to 4.0 cm of water per land unit, applied a wide range of herbicides, fungicides, and insecticides to various multiple-cropping sequences with pest control results equal to or exceeding equivalent application of pesticides with ground equipment. Irrigation equipment costs less per land unit to operate than standard pesticide application equipment and at the same time applies water to the crop. The above results show that center pivot irrigation equipment can be used as an economical, effective, and safe method of pesticide application.

Weeds reduce the yields of vegetables - Weslaco, TX. Research on weed interference with growth of vegetables has shown that onions must be kept weed-free for at least six weeks after emergence to avoid losses in quality and yield. Even one wild sunflower weed per 3 feet of onion row (one weed per 15 onion plants) will decrease the yield of onions. This information is important in the design of weed management systems because herbicides suitable for control of several weed pests in onions must be applied after weed and crop emergence but before loss in crop yield or quality.

Weeds reduce mint oil quality - Prosser, WA. When mint hay containing weed foliage was distilled, mint oil quality was reduced significantly by: 5 percent lambsquarters, 10 percent western goldenrod, 10 percent redroot pigweed, and 20 percent prickly lettuce. Barnyardgrass did not reduce oil quality.

Technological Objective 4.

> New and improved weed control technology for use in forage crops, pastures, rangelands, and turf that will increase efficiency of food and feed production, improve aesthetic values, reduce losses in yield and quality, and reduce the cost of control.

Research Locations:

5514	Flagstaff, Arizona	5208	Reno, Nevada
5502	Tucson, Arizona	1307	Ithaca, New York
7702	Tifton, Georgia	5809	Corvallis, Oregon
1103	Beltsville, Maryland	7302	College Station, Texas
3402	Columbia, Missouri	7307	Temple, Texas
3416	Lincoln, Nebraska	5702	Logan, Utah

Following are some examples of recent progress:

New methods of controlling yellow nutsedge in the northeast - Ithaca, NY. The herbicide glyphosate applied to yellow nutsedge at the appropriate growth stage followed by a supplemental disking operation controlled this troublesome species sufficiently to allow newly planted alfalfa to establish in an excellent manner. This method of nutsedge control will allow greater flexibility in the time for planting alfalfa. Summer plantings with limited tillage are now more feasible.

Economical combinations of herbicides for weed control in forages - Ithaca, NY. The effectiveness of EPTC and dinoseb herbicides used in combination for weed control, which resulted in increased yields of red clover and birdsfoot trefoil, was balanced against input costs. The result was a more sound basis for choice of herbicide combinations and rates for weed control and forage production. In many cases, input costs of the farmer can be lowered.

Practical methods for direct planting of legumes in grass sods - Ithaca, NY. Individual grass sods vary considerably in susceptibility to herbicides and therefore may respond differently to attempts to establish legumes in them by limited-tillage or direct plantings. The best herbicide and rate among glyphosate, dalapon, and paraquat for grass and weed control

in sods of bluegrass, timothy, orchard-grass, tall fescue, rye grass, and quackgrass were determined in a three-year study. These findings will facilitate the direct planting of legumes in sod and result in more economical farming and better soil conservation.

Pilot program on alternate means of weed control in no-till systems gets a good start - Ithaca, NY. In pilot program tests, severe grazing pressure plus glyphosate applications for weed control prior to the direct planting of red clover and birdsfoot trefoil resulted in establishment and greater yields than grazing or herbicide pressure alone. Farmers will be able to use grazing animals in addition to selected herbicides to control weeds at reduced cost and less negative impact to the environment. In other pilot tests in 1978, 95% of the plantings of red clover and birdsfoot trefoil planted directly without plowing into sods killed by glyphosate, were successful. Where paraquat was the herbicide used, 78 percent of the plantings were successful. Causes for failure were identified as insufficient weed and insect control and too high soil acidity. This program will define the conditions under which direct planting of forage in sod is likely to succeed.

Rope wick applicator devices reduce amount of herbicides applied to pasture weeds with safety to forages - Columbia, MO. Devices were developed to hold rope wicks that make it possible to wipe herbicides on the tops of weeds that grow above forage crops. These devices are economical to make, reduce the amount of herbicide applied, keep herbicides from reaching susceptible forage crops, and are effective for controlling pasture weeds.

New herbicide for weed control in kleingrass and buffelgrass - College Station, TX. Propazine, a triazine preemergence herbicide, shows promise for control of annual weeds in newly seeded kleingrass or buffelgrass stands. The grasses are relatively new introductions from South Africa and are manifesting excellent adaptation to pastures and rangeland in Texas, but require adequate weed control for successful establishment.

New herbicides for brush control - College Station, TX. Picloram and tebuthiuron continue to be highly effective for control of most woody species in central Texas. Ustilan and hexazinone are new herbicides applied as soil treatments (granules) that are showing promise for control of certain woody plants. Triclopyr, a new foliar applied herbicide is being investigated and compared to 2,4,5-T in general effectiveness on weeds and brush.

Evaluation of releases of insect weevils for control of musk thistle - Lincoln, NB. At the site of initial release of the insect weevil, Rhinocyllus conicus, in Valley County, Nebraska, populations of the weevil continue to build and spread. Additional collections of weevils were made in Bozeman, Montana, and releases made in 24 counties in eastern and central Nebraska. This makes a total of 32 counties in which releases of the weevil have been made. An early release in Pawnee County has spread to more than 1000 acres with good distribution but population densities are not yet to a point of materially inhibiting thistle weed production.

Effective alternatives to herbicide sprays for control of common goldenweed, Temple, TX. The comparatively high amounts of leaf wax on common goldenweed explain why it is not affected by spray treatments which control other goldenweed species. Fortunately, prescribed burning is an effective alternative to herbicide sprays for management of rangeland and pastures infested with common goldenweed, and the combination of burning and soil-applied herbicides reduces by half the amount of herbicide required for control.

Metabolism of tebuthiuron by plants correlated to tolerance-Tucson, AZ. An apparent positive correlation was found between the tolerance of range plants to tebuthiuron and their ability to metabolize this herbicide. This discovery could serve as an aid in determining which plant species will be controlled by tebuthiuron and in which range-plant communities it should be used.

Long-term forage production increased with increasing rates of tebuthiuron - Tucson, AZ. Areas treated with tebuthiuron for control of velvet mesquite and associated woody species consistently produced more forage for two years or more after treatment than non-treated areas with similar woody plant infestations. In addition, it was found that areas treated with tebuthiuron at rates in excess of those necessary for complete control of the woody plants produced more forage than plots treated at lower rates which gave complete control. Higher rates of this persistent herbicide may be contributing to more rapid break down of the killed plants, thus, increasing the rate of nutrient cycling, or it may be controlling annual ephemeral plants which are not present at the time forage evaluations are made in the fall. This information is important because it indicates the potential productivity of southwestern rangelands and suggest that this herbicide may serve a role in addition to brush control in forage production.

Modification of commercial ground sprayers provide ranchers with efficient equipment for brush control - Reno, NV. Commercial ground sprayers were modified by strengthening booms, supports, and other parts that receive extremely hard use under rangeland conditions. Boom height adjustments were changed to accomodate spraying at heights above brush. A dye marker system was also included on the sprayers to identify spray swaths on rough terrain. These modifications enable spraying of brush on rangelands by individual ranchers where aerial application would not be feasible.

Identification and characterization of soil surface types on rangelands aids in range seeding - Reno, NV. Coppice soils (under shrubs) and interspace soils (between shrubs) with intermediate types on Intermountain rangelands provide greatly differing soil surfaces in regard to water penetration, fertility level, and seedling emergence. Interspace soils often have very hard surfaces that are infertile and almost impossible for grass seedlings to penetrate. Coppice soils are friable, have high organic content, and provide excellent media for grass seedling emergence and plant growth. Identification of these soil-surface types and their relative areas are important in artificial revegetation and natural revegetation under livestock grazing systems on rangelands.

Identification of toxic compounds in introduced species - Logan, UT. Preliminary studies indicated that kleingrass poisoning could be experimentally

produced in cattle. Kleingrass poisoning was previously known to occur only in sheep and goats. Many new foreign species of Astragalus and Indigofera were found to contain nitro compounds. This information is important to plant introduction personnel since it identifies poisonous species that should not be considered for use as forage. Galenia, which could become a serious pest if released, was intercepted through toxicological examination.

Technological Objective 5.

New and improved weed control technology for controlling, managing, or using weed populations to improve water quality, fish and wildlife habitats, and recreational areas in aquatic and noncropland sites.

Research Locations:

5100	Albany, California	7615	Fort Lauderdale, Florida
5206	Davis, California	7402	Stoneville, Mississippi
5604	Denver, Colorado	5806	Prosser, Washington

Following are some examples of recent progress:

Herbicides applied in irrigation water control weeds in beans - Prosser, WA. Alachlor, EPTC, EPTC + trifluralin, and EPTC + oryzalin applied in irrigation water through sprinklers controlled barnyardgrass, lambsquarters, pigweeds, and hairy nightshade selectively in beans. Herbicides were applied with a sprinkler irrigation system specially designed for research purposes. These results show that the sprinkler system can be used to apply herbicides to small research plots, and thus the principles that affect the performance and behavior of herbicides applied through sprinklers can be elucidated more fully.

Method of selectively controlling a weedy perennial grass in mixed stands of perennial grasses developed - Prosser, WA. Applying glyphosate at a critical time in the life cycle of different grasses has proven to be an effective and economical method of selectively removing a weed grass (reed canarygrass) and several other weedy species from plant communities that include creeping red fescue (a desirable ditchbank grass). This development will make it possible to establish and maintain a desirable grass cover near the waterline of waterways. Currently, these sites are infested with species that drastically reduce the flow of water, harbor insects that are of importance to economic crops, and that produce weed seed that is transported via the water to irrigated farmland.

Biologically active phytotoxic compounds isolated and identified from spikerush - Albany, CA. Several compounds have been isolated and identified from spikerush, a competitive aquatic plant that controls aquatic weeds. These include the flavanoids, tricin and luteolin plus a number of sterols and phenolic acids. Luteolin, as well as some of the phenolic acids, has shown some activity in suppressing root growth of watercress seedlings. A cyclic terpene lactone, dihydroactinidiolide, has been isolated, characterized and synthesized; it shows substantial activity as a biocide. An improved, more sensitive bioassay system has been developed using undifferentiated rose cells. Some extracts of spikerush have approximately the same biocidal activity as the known biocide, juglone.

Water stress makes aquatic weed susceptible to herbicides - Denver, CO. Greenhouse studies have shown that the aquatic weed American pondweed is susceptible to several foliar-applied herbicides when the plant is forced to produce terrestrial-like leaves by moisture stress or in response to the plant growth regulator abscisic acid. Field research is planned to determine if the pondweed can be controlled by use of water stress conditions and foliar applications of herbicides already registered by the EPA for use in irrigation systems.

New approach to use of copper sulfate can improve its performance and cut costs of algae control - Davis, CA. Copper sulfate applied to water for control of algae in a concrete-lined canal was found altered very quickly to states having little or no toxicity to algae. Application of copper sulfate in a 3 to 5 percent solution of sulfuric acid increased the concentration of copper ion, the phytotoxic state, as much as tenfold 0.65 miles downstream from the application site. A five-fold increase in the concentration of ionic copper was retained at 6.23 miles downstream from the treatment site. Although it will take several years to complete the investigations, results of one season's work indicate good potential for improved control of algae at less expense and sharply reduced quantities of copper used in aquatic sites.

Allelopathic compounds extracted from dwarf spikerush, - Davis, CA. A crude extract obtained from dwarf spikerush by extraction with 40 percent aqueous ethanol, evaporation of the ethanol, and back-extraction with either diethyl ether or ethyl acetate, exhibited phytotoxic characteristics in several bioassays. Minute fractions of the crude extract showed marked allelopathic activity on growth of watercress roots, tissue cultures, and growth of germinating sago pondweed seed. The fractions are being refined, enriched, and identified. This discovery may provide an entirely new approach to control of aquatic weeds.

Herbicides control aquatic weeds - Fort Lauderdale, FL. Herbicides applied to rooted emersed torpedograss were less effective than treatments applied to plants rooted in water. Hexazinone controlled hydrilla in outside aquaria over a 12 month period and reduced propagule production to 0.7 percent of controls. Over 26 months of control was obtained in field research. An apparent synergism between fenac and copper has increased by 95 percent the rate of phytotoxic response of hydrilla to fenac treatments. Field research to confirm these findings are in progress. A single application of fenac has controlled hydrilla in a 8 ha lake for over 16 months. A new growth retardant applied to clipped hydrilla stems prevented regrowth for 24 weeks. Results of preliminary studies investigating the relationship of aquatic and terrestrial habitats to translocation of glyphosate in torpedograss indicate that translocation of absorbed herbicide was greater in plants from a terrestrial habitat.

Insects show promise for control of aquatic weeds - Fort Lauderdale, FL. Sameodes albiguttalis (Lepidoptera:Pyralidae) has been released on waterhycinth in south Florida at 15 sites (a total of 37 adult insects, 2800 larvae, 30 pupae, 4000 eggs, and 2177 infested plants). Populations are established at 4 of these sites. The insects do best in areas of luxuriant plant growth typified by the small bulbous petioled morphotype of the plant. Studies with Neochetina eichhorniae (Coleoptera:Curculionidae)

indicate that high populations can eradiacate stands of small waterhycinth plants. If the eradication is not complete the surviving plants will respond numerically to produce a maximum population limited only by the available space. Stands of large waterhyacinth plants show very little effect from N. eichhorniae due to a lack of damage by the weevils to the youngest leaves. A survey is being conducted to determine the species of native insects that feed upon Hydrilla verticillata and Myriophyllum spicatum. Thus far, 20 collections of M. spicatum have been made from 41 sites in 4 States. Thousands of insects have been collected and identifications are pending.

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National Research Program 20290

AGRICULTURAL CHEMICALS TECHNOLOGY FOR
CROP PROTECTION AND MODIFICATION

This basic, multidisciplinary, national research program deals with the development of new knowledge, new concepts, and new principles on the relationship of chemical structure to biological activity; including the nature, behavior, and fate of chemicals in soils; their mechanisms of entry, movement, activity, selectivity, metabolism, and fate in plants; their performance efficiency; and safety to crops, soils, and nontarget organisms in the environment. This research is essential to the efficient and safe use of pesticides and plant growth modifiers in the development of high-yielding food, feed, and fiber agroecosystems that will maintain the nation's food supply and improve the quality of the environment. This program supports the missions and goals of SEA and the Department. It is organized into 33 projects at 15 locations and is conducted by 28 SEA scientists in cooperation with several Federal agencies, State agricultural experiment stations (SAES), private universities and research institutes and industrial research organizations.

NPS Contact: W. C. Shaw

Technological Objective 1.

New concepts and knowledge for improving the primary evaluation and structure-activity assessments for enhanced development of improved herbicides, fungicides, nematicides, insecticides, and growth regulators that are compatible with a quality environment.

Research Locations:

5102	Albany, California	1208	Frederick, Maryland
3102	Peoria, Illinois	7092	Raleigh, North Carolina
7100	New Orleans, Louisiana	3602	Fargo, North Dakota
1103	Beltsville, Maryland	1402	Philadelphia, Pennsylvania
1110	Beltsville, Maryland	7302	College Station, Texas

Following are some examples of recent progress:

New simple fly sterilant - Albany, CA. Chemosterilants have not been used to any extent for the control of insect populations because known sterilants (such as tepa) have proved to be mutagenic, toxic to animals, or inefficient. A simple benzyl phenol (J2644, 2,4-di-t-butyl-6-(4-methoxy= benzyl) phenol) has now been shown to be an excellent fly sterilant. Since it can be synthesized cheaply and easily and is nonmutagenic in the Ames test, this compound may provide a safe, efficient chemosterilant for use in the field, if the nonmutagenicity and low animal toxicity are substantiated in further more extensive research.

New classes of nematicides - Beltsville, MD. Very high levels of nematicidal activity have been discovered in two new classes of chemical compounds. These compounds are similar to previously reported amines and

amides but differ from them in kinds and positions of substituents. In preliminary evaluations they are far more active than commercially available standard nematicides evaluated under the same conditions. In addition, they appear to promise increased safety and environmental compatibility. In feeding tests, the most active were nontoxic at 300 mg/kg (acute oral dosages, rabbits). Studies to fit them for use on crop plants under practical field conditions are underway.

Biologically active plant steroid identified - Beltsville, MD. Through the cooperative efforts of scientists at NRRC, ERRC, and BARC, enough crystals were obtained from the extraction of 180 kg rape pollen to identify the extremely biologically active plant steroid, brassinolide. The level of this molecule in rape pollen is about 100 parts per billion. Brassinolide applications to bean internodes in microgram quantities under bioassay conditions result in rapid localized growth that causes the internodes to split. In the presence of auxin, a natural plant hormone, brassinolide enhances the auxin response of bean segments as much as fourfold. A project to synthesize brassinolide or an active analogue is underway as are physiological studies to determine how this new and unique growth regulator can be utilized in agriculture and to determine its role in the physiology of plant growth and development.

Aircraft herbicide application equipment developed - College Station, TX. A positive-feed vaned-rotor metering system was developed to improve the accuracy of application of herbicide pellets by aircraft. Rotor speed governs the discharge rate. A nylon bristle brush prevents pellet flow when the rotor is not turning. Flight tests and field plot applications proved the system to be practical and capable of close control of pellet delivery rate.

Bioactive compounds are evaluated rapidly in whole plants - Frederick, MD. Solutions of chemicals can be injected into the hollow stems of beans to see if they speed up or slow down plant growth or change its development. The reaction of the whole plant is measured without need for complicated techniques or equipment, and one can tell in a few days if a new chemical might have use in regulating plant growth.

New method developed to detect plant bud growth inhibitors - Frederick, MD. A method involving quackgrass rhizomes was developed to detect bud growth inhibitors. In validation experiments, bud outgrowth and shoot length were inhibited significantly by NAA and ABA.

New class of plant growth regulators affects rancidity of oil, fatty acid composition of oil seeds and insect lipids - Beltsville, MD. In greenhouse studies substituted pyridazinones significantly reduced levels of linolenic acid in soybean oil indicating a possible chemical method for removal of the rancidity factor responsible for poor oil quality. In field studies substituted pyridazinones significantly altered the fatty acid composition of sunflower seed oil, indicating a possible means for stabilizing of oil quality. Rearing tobacco bud worms on a diet containing 0.1 percent w/w substituted pyridazinone revealed that the chemical also affects insect lipids and produced growth regulatory effects leading to decreased survival.

New chemicals and controlled release formulations show promise in improving chemical weed control technology - Beltsville, MD. Twenty chemicals synthesized as potential insect chemosterilants were evaluated for their herbicidal properties using a preemergence test tube technique. The N-(4-fluorophenyl)-N'-hydroxy-[(trifluoromethyl)phenyl]urea has potential of controlling certain broadleaf and grassy weeds in rape, soybeans, and cucumbers. The N'-(3,4-dichlorophenyl)-N-methylurea has promise for the control of broadleaf and grassy weeds in corn. Thiomidocarbonic acid appears specific for pigweed control. The N-methyl-N'-[4-phenylmethoxy)=phenyl]urea has potential for the control of some broadleaf and grassy weeds in corn and soybeans. Eight new chemicals from six companies were evaluated in the field on more than 36 crop and weed species. Greenhouse and field studies showed that starch xanthate formulations of trifluralin gave residual weed control over longer periods of time than conventional commercial formulations. Starch xanthate and ureaformaldhyde formulations of propham and chlorpropham were herbicidal for longer periods of time than several liquid formulations.

Technological Objective 2.

> New and improved knowledge of the nature, behavior, and fate of agricultural chemicals in soils that influence the performance of pesticides and growth modifying chemicals and their safety to crops, soils, and nontarget organisms in the environment.

Research Locations:

1103 Beltsville, Maryland
7402 Stoneville, Mississippi
7403 Stoneville, Mississippi

Following are some examples of recent progress:

Rate of dissipation and the mobility of herbicides in soil determined - Stoneville, MS. The residual activity of fluridone in soil was evaluated through bioassay and chemical analysis of soil samples taken from treated field plots and from greenhouse persistence studies. Phytotoxic effects were detected by sorghum bioassay in field soil samples 18 months after application at 1.1 kg/ha. Persistence for periods in excess of 1 year have been detected in soil treated for greenhouse studies. This information suggests that residues may damage crops unless crop rotations are designed to avoid periods of residual phytotoxicity.

Technology to reduce photodecomposition of soil applied herbicides developed - Stoneville, MS. Several compounds capable of absorbing large quantities of ultraviloet radiation are being evaluated as possible spray additives to reduce photodecomposition of herbicides applied to the soil surface. P-aminobenzoic acid has demonstrated some positive effects in retarding the photodecomposition of pendimethalin in preliminary studies under artificial light. The effectiveness of this ultraviolet absorbing material under actual field conditions has not been evaluated. Other ultraviolet absorbers and herbicides are also being evaluated in an effort to improve herbicide performance and safety.

New systems for determining herbicide uptake by plants developed - Stoneville, MS. Hydroponic systems were developed for evaluating the effect of arsenical herbicides on As uptake and subsequent effects on growth of soybean and rice plants. Soybeans were more tolerant to arsenic than rice plants. Soybean root and shoot development was decreased by As concentrations in excess of 5 to 7.5 ppm; while rice shoot growth was decreased by As concentrations as low as 0.3 ppm. Rice plant tissue accumulated much higher levels of arsenic than did soybean plants when grown on soil treated with 15 ppm As as MSMA.

Simple equation predicts agricultural pesticide pollution of rivers and streams - Stoneville, MS. Using data collected from 15 years of research all over the United States, a simple equation has been developed which predicts the concentration of pesticides in water draining from agricultural fields. Intended for use in water quality planning, the equation provides rough estimates in situations where exact data are not available.

Controlled-release formulation of metribuzin chemically bonded to polymer matrices offers potential benefit - Stoneville, MS. The synthesis of polymer systems containing metribuzin bonded chemically to such biodegradable polymers as cellulose or polyvinyl alcohol appear, through extensive laboratory and greenhouse studies, to offer a great potential for making more efficient use of this herbicide while improving environmental safety.

New synthetic pyrethroid insecticides are biodegradable in soil - Beltsville, MD. The soil persistence and biodegradability of a new generation of insecticides, the synthetic pyrethroids (cypermethrin, decamethrin, and permethrin) were studied. Although the rate of degradation varies with the compound, the application rate, soil type, temperature and aeration, and the chemicals isomeric form, at normal application rates (0.02-0.2 lb/A), their degradation occurs rapidly and extensively in nearly all of the soils examined. The major degradation pathway involves a simple hydrolysis to yield products which are also rapidly metabolized by soil microorganisms to CO_2 and other ecologically acceptable products.

Long-term arsenic uses shows no effect - Beltsville, MD. Experiments were conducted to examine the long-term effects of arsenical herbicide use on plant and soil systems. Results after seven years indicate that no adverse effects can be anticipated from their continued use on soil and plant contents, nor on plant growth at normal application rates. Slight increases in phytotoxicity and crop residues are observed at twice the recommended rate.

Aquatic ecosystems useful for metabolic research-Beltsville, MD. The utility of larger laboratory microecosystems for detailed metabolic studies on multiple ecosystem components was demonstrated by significantly increasing ecosystem size, quantity of biomass and amount of radiolabeled test compound. A scaled-up version of our standard aquatic laboratory microecosystem was used to obtain sufficiently large soil, aquatic organism and water samples that the metabolic fate of the herbicide, trifluralin, could be followed in each of these components. Results closely followed the known degradation pathways for soil, water, and aquatic organisms. This research has shown that large laboratory microecosystems can be used

to confirm (in one experiment) a wide range of environmental fate data usually obtained in a series of small laboratory experiments.

Microagroecosystem chambers may reduce costs of determining fate of pesticides in the environment - Beltsville, MD. Chambers were developed to monitor the fate of pesticides in the soil, plant, water, and air components of the environment simultaneously. Compared results with field data indicate reasonably good correlations. This will aid researchers to collect initial information on pesticides in the total environment more rapidly and cheaper than in the field.

Technological Objective 3.

> New and improved knowledge on the mechanisms of entry, movement, activity, selectivity, metabolism, and fate of applied pesticides and growth regulators in relation to their effective action in plants and their safety to subsequent crops and nontarget organisms.

Research Locations:

8001	Beltsville, Maryland	1109	Beltsville, Maryland
8003	Beltsville, Maryland	7802	Raleigh, North Carolina
1103	Beltsville, Maryland	3602	Fargo, North Dakota

Following are some examples of recent progress:

Witchweed germination stimulants may aid control - Raleigh, NC. Three of 10 compounds, intermediates in strigol synthesis, obtained from SRRC, USDA, New Orleans, were active in stimulating witchweed seed germination. Two more showed some activity if dissolved in DMSO. DMSO had the least adverse effect on seeds of several organic solvents tested. Two very active strigol analogs from the University of Sussex, in England, (GR 7 and GR 45) were inhibitory to conditioning at concentrations that stimulated germination. Exposure to strigol for 2 hours after conditioning is sufficient for germination. Ethylene released in these studies was correlated with percent germination and strigol concentration. Ethylene also overcame strigol-inhibition of the conditioning process. The results indicate that strigol would not interfere with the field use of ethylene. These studies indicate that strigol should be active in soil under field conditions in stimulating seed germination, and should aid in developing improved methods of witchweed control.

Herbicides interact with plant membranes - Raleigh, NC. Many important herbicides, including chlorpropham, perfluidone, propanil, and trifluralin, have been known to interfere with the oxidative and photoproduction of ATP energy by isolated mitochondria and chloroplast, respectively. However, the mechanism through which inhibition was expressed has not been established. Recent research has suggested that the herbicides may produce inhibition by inducing alterations to the fluidity and permeability of the organelle membranes. This observation provides a clearer understanding of how herbicides kill plants and should be useful in developing new and more selective herbicides.

Improved sunflower disease control - Fargo, ND. In 1978, stalk-rot and heat-rot (Sclerotinia spp.) were serious disease problems in the major sunflower production area of the United States. Effective fungicides for the control of this disease are limited, and resistant sunflower varieties are not available. Preliminary research has identified three experimental compounds that effectively control the disease organism in in vitro laboratory research.

Basic research provides basis for improved wild oat herbicide performance - Fargo, ND. Metabolic oxidation reduces the phytotoxicity of the wild oat herbicide, diclofop-methyl. Oxidation inhibitors have been used simultaneously with the herbicide to prevent detoxication. This increases the effectiveness of the herbicide in wild oat and makes it possible to use less herbicide with equal effectiveness. Wild oat plants are injured most readily when diclofop-methyl is placed on the stem. Field application techniques must assure that the herbicide is applied to the lower parts of the weed because contact with leaves may cause only temporary damage. Improved diclofop-methyl performance with better placement and synergists is important in achieving reduced costs and greater environmental safety.

Mechanism of pesticide-surfactant interaction in photochemical degradation - Fargo, ND. Nonionic surfactant solutions at concentrations in excess of the critical micelle concentration increase the photochemical degradation rate of the herbicide, monuron. Photochemical reactions appear to occur in the organic phase of the micelle rather than in the aqueous phase of the solvent. These studies are important as a model for many biological and environmental systems that involve pesticide interactions with lipophilic materials, including surfactants, oils, lipids, and membranes.

New concepts of pesticide additive behavior and fate in plants - Fargo, ND. The use of specific nonionic surfactant molecular structures in studies of their behavior and fate in plants has shown that these important pesticide formulation ingredients are rapidly absorbed and transformed by metabolic reactions similar to those reported for pesticides. These studies indicate that cellular biochemical events as well as surface/physicochemical and membrane interaction/solubilizing factors may affect the selective activity of a pesticide formulation.

Metabolism studies in pesticide development and registration - Fargo, ND. Industry normally allots three scientific man years to complete a metabolism study on a new pesticide. New techniques and analytical methods developed to study glutathione conjugation, a major detoxication pathway of many leading pesticides used in the United States, together with detailed metabolism information derived from model studies with PCNB and atrazine provide substantial savings in time and money needed for the development of many new pesticides.

Technological Objective 4.

> Develop new information on natural bioconstituents and related synthetic compounds that control physiological and biochemical processes for the development of chemicals to modify plant structure and processes.

Research Locations:

7702	Tifton, Georgia	7102	New Orleans, Louisiana
3102	Peoria, Illinois	1402	Philadelphia, Pennsylvania
1109	Beltsville, Maryland		

Following are some examples of recent progress:

New growth regulators characterized - Beltsville, MD. The growth inhibitor isolated from the tree of heaven (Ailanthus altissima) has been partially characterized as a derivative of ailanthone, a sesquiterpene lactone (quassinoids). This water-soluble compound has allelopathic properties as observed using tobacco and beans. Growth-stimulating activity of several crop plants has also been discovered with an extract obtained from A. altissma. Salts of camptothecin alkaloids, a naturally occurring growth regulator, have controlled sprouting of six varieties of potatoes when applied as a spray or dip in replicated experiments.

Several chemicals related to brassins show growth regulating activity - Beltsville, MD. The partially purified brassin sample representing about 180 kg of pollen was fractionated by high performance liquid chromatography (HPLC) to give a very highly active component which was further purified by recrystallization. The crystalline brassinolide was active even at nanogram levels as determined by the bean second internode bioassay. Several synthetic steroidal compounds bearing close structural resemblances to brassinolide, were evaluated for cell elongation and cell division responses via the bean second internode bioassay. One such structural isomer of brassinolide showed marked brassin activity.

Molecular structure of brassinolide, a plant growth regulator, determined - Peoria, IL; Philadelphia, PA; and Beltsville, MD. Through the cooperative efforts of scientists at NRRC, ERRC, and BARC, enough crystals were obtained from the extraction of 180 kg rape pollen to identify the extremely biologically active plant steroid, brassinolide. Spectroscopic and cyrstallographic data show that the active steroidal molecule has an empirical formula of $C_{28}H_{48}O_6$ and a molecular weight of 480. A cooperative project to synthesize brassinolide or an active analogue is underway as are physiological studies to determine how this new and unique growth regulator can be utilized in agriculture and to determine its role in the physiology of plant growth and development.

Brassinolide, a new growth regulator, causes unique plant growth responses - Peoria, IL. In cooperative research with BARC and ERRC, a novel plant growth promoter, brassinolide, has been isolated, and the chemical structure has been established. Brassinolide stimulates elongation, swelling, and splitting of bean internodes. This combination of responses is unique and unexpected. Brassinolide represents the first steroid-type molecule to show growth-promoting activity in plants. Previously, steroids were well known as animal hormones, but no physiological activities were known in plants. Further research is required to learn what effect brassinolide or related compounds may have on increasing crop yields.

New stimulants for witchweed seed germination - New Orleans, LA. Two chemicals produced as part of the laboratory synthesis of strigol, a naturally occurring witchweed seed-germination stimulant, have shown activity as a witchweed seed-germination stimulant. Greater than 70 percent germination of viable witchweed seed has been achieved with the two new stimulants. These two chemicals require substantially fewer steps to prepare than strigol, and they are almost as effective as strigol. If witchweed can be germinated uniformly with the aid of stimulants, then only one application of herbicide will be needed to control this weed.

Controlled-release formulations based on the reaction product of metribuzin-formaldehyde with cellulose provide a wide range of release rates - New Orleans, LA. Controlled-release formulations based on cellulose were prepared by the reaction of mixtures of the herbicide metribuzin and formaldehyde with cotton in the presence of an acidic catalyst. Release rates of the herbicide can be varied over a wide range by proper selection of reaction conditions. Metribuzin, a widely used soybean herbicide, has a relatively high water solubility and is not persistent through the growing season because of leaching by rain and irrigation. The cellulose reactive formulation provides an insoluble slow-release form of metribuzin which could give significantly improved weed control.

Alginate-encapsulated molinate effective in control of barnyardgrass - New Orleans, LA. Technology has been developed whereby herbicides can be encapsulated in alginate gels in the form of small spheres. Molinate, which is used for weed control in rice fields, was alginate-encapsulated and found superior to the commercial formulation of molinate in the control of barnyardgrass in rice. Furthermore, the grain yields were uniformly higher with the experimental molinate formulation.

Sinking and floating forms of alginate-encapsulated 2,4-D control watermilfoil - New Orleans, LA. The development of both sinking and floating forms of the gel spheres has permitted the use of herbicides against both submerged and floating forms of aquatic weeds. Initial evaluation of alginate-encapsulated 2,4-D in both forms indicate they are effective in controlling watermilfoil, a serious aquatic weed pest in the Southeastern United States.

Technological Objective 5.

> Improved automated search, storage, and retrieval systems for relating chemical structure and biological activity of pesticides and growth regulators, including their nature, behavior, and fate in all aspects of the environment.

Research Locations:

1208 Frederick, Maryland

Following are some examples of recent progress:

Improved storage and retrieval system for herbicides and growth regulators developed - Frederick, MD. The Frederick chemical data base of 31,000 compounds has been placed on tape, transferred to SEA, and is available for

retrieval by the Data Systems Application Division. The chemical structure diagrams from the Mitchell file of plant growth regulators have been translated into WLN and validated. Biological response data for 6000 of these compounds has been put in form suitable for computer use. The chemical names of 2000 compounds from the Shaw-Gentner file have been placed on tape and printed out to develop structural diagrams and WLN descriptions. Workshop materials have been developed to train SEA scientists in the use of WLN for all aspects of chemically related information.

Chemical data base available for use in weed science - Frederick, MD. Researchers can now use a computerized storage and retrieval system that contains information on many chemicals that have been evaluated for biological activity. Training aids have been developed that permit the biological scientist to use this unique "library" to obtain many kinds of chemically-related information that are important in herbicide research. The scientist can, for example, find if there are close chemical relatives of herbicides of current interest that should be researched to develop new uses.

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Special Research Program

MINOR USE PESTICIDES

Technological Objective: Develop data for use in registration of pesticides for minor crops, minor uses on major crops, and speciality uses.

This Special Research Program involves availability of pesticides for minor and special uses by the agricultural community and assures continuation of crop and livestock production technology for production, storage, distribution, and marketing of food, feed, seed, and fiber. These technologies will result in lowering the cost of fruits, vegetables, and other agricultural commodities and increase the efficiency of production of these crops to growers, small farmers, and homeowners. Entomologists, plant pathologists, weed scientists, chemists, and nematologists work in a team approach to develop the data required to register minor use pesticides.

NPS Contact: P. H. Schwartz

Research Locations:

5210	Riverside, CA
5205	Salinas, CA
7706	Byron, GA
7705	Savannah, GA
7702	Tifton, GA
3311	Urbana, IL
3303	Vincennes, IN
1108	Beltsville, MD
1110	Beltsville, MD
1208	Frederick, MD
1305	New Brunswick, NJ
3306	Delaware, OH
5809	Corvallis, OR
7711	Charleston, SC
7202	Weslaco, TX
5702	Logan, UT
5806	Prosser, WA
5805	Yakima, WA

Following are some examples of recent progress:

Scientists in Agricultural Research cooperated with state scientists on 71 food requests in IR-4 during 1978 and 405 ornamental requests. These projects were conducted at 17 locations in AR. Of these projects 52 food projects and 301 ornamental projects were completed in 1978.

The IR-4 program currently has a backlog of about 400 food requests and they are receiving 50 new researchable projects a year. About 1,046 ornamental requests have been assembled into data packages leaving 2,185 priority 1 and 2 projects to be researched. About 4,000 priority 3 and 4 ornamental projects will need research data eventually.

SELECTED PUBLICATIONS

See appropriate NRP listing.

Special Research Program

PILOT TESTING OF ALTERNATIVE METHODS FOR PEST CONTROL

Technological Objective: To rapidly advance newly emerging technology toward implementation in order to (1) reduce net losses from pests, (2) to reduce the impacts of pest control technology on the environment either by improving current technology or by developing new technology, and (3) to reduce the hazard to man of pest control technology.

The purpose of this Special Research Program is to secure the development and commercial use of methods of pest management that tend not to produce adverse environmental impacts and which are essentially safe for people. In other words, the new technology must be free of the problems which attended many of the broad spectrum insecticides such as hazard to man, biomagnification, toxicity to nontarget species, etc. To a limited extent, this Program will include developmental research which includes optimization of the use of environmentally hazardous pesticides. This program will foster the application of the methods of systems science in dealing with pest problems. The long-range goal is to find enduring pest management systems that would assure stable agricultural production and marketing.

NPS Contact: Waldemar Klassen

Research Locations:

5510	Phoenix, Arizona	7402	Stoneville, Mississippi
5206	Davis, California	3402	Columbia, Missouri
5602	Fort Collins, Colorado	5208	Reno, Nevada
1213	Newark, Delaware	5507	Las Cruces, New Mexico
7602	Gainesville, Florida	1307	Ithaca, New York
7706	Byron, Georgia	7803	Oxford, North Carolina
7702	Tifton, Georgia	7203	Brownsville, Texas
3302	Lafayette, Indiana	7313	Lubbock, Texas
7409	Lake Charles, Louisiana	7202	Weslaco, Texas
1110	Beltsville, Maryland	5805	Yakima, Washington
1208	Frederick, Maryland	3507	Madison, Wisconsin
7502	Starkville, Mississippi		

Following is a list of project titles and locations. Examples of recent progress are included in the appropriate NRP reports.

NER-77-1 - Nationwide establishment of an aphid predator. (Newark, DE).

NER-77-3 - Management of insects and diseases in orchards of dwarf apples. (Beltsville, MD).

NER-77-4 - Suppression of nematodes with hormonal growth regulators. (Beltsville, MD).

NER-77-5 - Suppression of rush skeletonweed with a pathogen. (Frederick, MD).

NER-78-1 - Integrated control of golden nematode. (Ithaca, NY).

NER-78-2 - Suppression of weeds by enhancing the competitiveness of forages in minimum tillage systems. (Ithaca, NY).

NER-78-3 - Avoidance of white rot in onions. (Beltsville, MD).

NER-78-4 - Suppression of face flies with sticky panel traps. (Beltsville, MD).

NCR-75-1 - Management of the cereal leaf beetle with resistant wheats. (Lafayette, IN).

NCR-77-1 - Suppression of Hessian fly by genetic means. (Lafayette, IN).

NCR-77-2 - Reduction of frost damage by suppressing epiphytic ice-nucleation-active bacteria. (Madison, WI).

NCR-77-3 - Development of a mixture and rate controlled sprayer. (Columbia, MO).

WR -75-1 - Alternative systems for managing weeds on irrigated farms. (Fort Collins, CO).

WR-77-1 - Systems of weed suppression and rangeland management on sagebrush grasslands of the West. (Reno, NV).

WR-77-2 - Systems of weed suppression and rangeland management of the Southwest. (Las Cruces, NM).

WR-78-1 - Cultural methods of suppressing weeds and aphid vectors of diseases of sugarbeets and potatoes. (Yakima, WA).

WR-78-2 - Use of resistant alfalfa in rotations to suppress root knot nematode. (Reno, NV).

SR-77-1 - Suppression of malarial mosquitoes with a nematode parasite. (Lake Charles, LA).

SR-77-2 - Suppression of peach tree borers with pheromones. (Byron, GA).

SR-77-3 - Suppression of filth breeding flies with parasites. (Gainesville, FL).

SR-77-4 - Management of citrus mealybug in the Rio Grande Valley. (Weslaco, TX).

SR-78-1 - Suppression of tobacco budworm with hybrid sterility. (Stoneville, MS).

SR-78-2 - Protection of sweet corn with semiochemicals. (Gainesville, FL).

SR-78-3 - Protection of tobacco by augmentative releases of stilt bugs and Bacillus thuringiensis. (Oxford, NC).

SR-78-4 - Tobacco budworm and plant bug resistant cottons in pest management programs for South Texas (Brownsville, TX).

SR-78-5 - Insect resistant cottons for humid areas (Stoneville, MS, and Starkville, MS).

SR-78-7 - Crop rotations for managing nematodes, diseases in weeds, in multiple cropping and minimum tillage systems. (Tifton, GA).

SR-78-12 - Augmentative biocontrol of silverleaf nightshade with a foliar nematode parasite. (Lubbock, TX).

SR-78-15 - Augmentative biocontrol of purple nutsedge by periodic releases of a weed-feeding insect. (Stoneville, MS).

SELECTED PUBLICATIONS

See appropriate NRP listing.

☆ U.S. Government Printing Office: 1979—310-947/359